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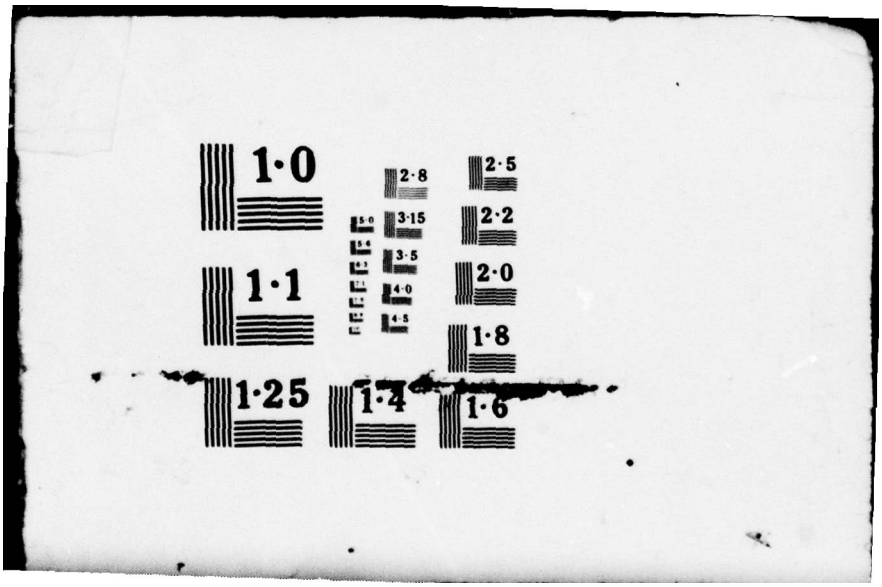
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This is volume VI of six volumes of training material prepared for an experimental course of maintenance instruction on the AAFCS M33 fire control system. This volume contains instructional material for the Maintenance and Supply Procedures subcourse of a program of fire control radar instruction. It contains lesson plans and review practical exercises designed to be covered in 101 periods of instruction.

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Technical Supplementary Material

for

HumRRO Technical Report 46:

DEVELOPMENT AND EVALUATION OF AN EXPERIMENTAL PROGRAM OF INSTRUCTION FOR FIRE CONTROL TECHNICIANS (RADAR VI)

Lesson Plans
Practical Exercises
Sample Forms

Prepared By
U.S. Army Air Defense Human Research Unit

Under the Technical Supervision of
The George Washington University
Human Resources Research Office
operating under contract with
The Department of the Army

Fort Bliss, Texas
June, 1958

FOREWORD

This is volume VI of six volumes of training material prepared for an experimental course of maintenance instruction on the AAFCS M33 fire control system. This material was developed during research conducted by the U.S. Army Air Defense Human Research Unit at Fort Bliss, Texas, in cooperation with the U.S. Army Air Defense School. A detailed account of the research, the results and recommendations emerging from the experiment, and the rationale by which these materials were prepared and used, is included in HumRRO Technical Report 46, "Development and Evaluation of an Experimental Program of Instruction for Fire Control Technicians." It is recommended that readers familiarize themselves with the contents of this report before attempting to use the training material contained in these volumes. A copy of this report may be obtained by writing to Director, Human Resources Research Office, The George Washington University, Washington 7, D. C.

VOLUME VI

MAINTENANCE AND SUPPLY PROCEDURES

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INTRODUCTION

This volume contains instructional material for the Maintenance and Supply Procedures subcourse of a program of fire control radar instruction that consists of the following subcourses:

I. Operation Orientation.
II. Electronic Fundamentals.
III. Acquisition Radar.
IV. Track Radar.
V. Computer.
VI. Maintenance and Supply Procedures.

It contains lesson plans and review practical exercises designed to be covered in 101 periods of instruction: 48 periods of conference, and 53 periods of practical exercises. Each instructional period is approximately 50 minutes in length. A detailed breakdown of instructional topics and time allotment is presented in table 1 page 3.

Throughout preceding subcourses, the student has been concerned with only a portion of the AAFCS M33 at a given time. The primary purpose of this subcourse is to provide the student with an opportunity for supervised practice in the maintenance of the AAFCS M33 as a whole. Therefore, instructional emphasis during this subcourse is placed upon the practical exercises. However, since administrative restrictions require that a balance be maintained between the time spent in practical exercises and in conference, the conference periods in this subcourse are devoted to the coverage of general maintenance-related topics which are not appropriate for inclusion in the subcourses devoted to specific portions of the AAFCS M33. The following are examples of such topics: "Use of Log Books," "Geographic Reference System," and "Supply and Administration."

Two short subcourses which follow Maintenance and Supply Procedures are concerned with electronics countermeasures (ECM) and information regarding the IFF system needed by the maintenance technician. These two subcourses were not modified for presentation in the experimental program but were presented in the standard manner. Therefore, no special material was prepared for these two subcourses.

Instructional material contained herein is that issued to instructors. Material issued to students was identical with two exceptions: (1) copies of practical exercises were not issued, and (2) instructor's notes, suggested explanations, and problems (shown in boxes in the lesson plans) were deleted.

A difference in format exists between material in this volume and that used during the research in that the experimental lesson plans were printed only on the left-hand pages of the volumes. This arrangement provided student and instructor with convenient and appropriate space for notes.

It will be noted that each page of lesson plans and practical exercises is coded at the top of the page. This code is interpreted as follows: the first letter "I" indicates that these publications are instructor material; the second letter indicates the volume (in this case, "M" for Maintenance and Supply Procedures), and the number following the dash indicates the number of the lesson plan in the volume. The code found on practical exercises is similar except for the "P" preceding the number that follows the dash.

Experience gained during the course of an experiment frequently enables researchers to suggest modifications in design and/or material that should lead to significant improvement of the product. Such modifications have been incorporated into these volumes to the possible benefit of the user and are indicated in two ways:

1. Changes relating to content are described in the introduction to each volume. No such changes have been recommended for volume VI.

2. Changes relating to topic time allotments are indicated in table 1. Numbers indicate recommended hours of instruction for each topic: where recommended time differs from time actually allotted during the experiment, actual time consumed during the experiment is indicated in parentheses.

Although material in this volume has been carefully prepared, imperfections may still exist. Your cooperation in eliminating them is

requested. Notification of errors and suggestions for improvement should be forwarded to the Director of Research, U.S. Army Air Defense Human Research Unit, Fort Bliss, Texas.

TABLE 1

Summary of Instructional* Periods Allotted to Topics Included in the Maintenance and Supply Procedures Subcourse

Topic	Conference	Practical Exercise
March Order	4	12
Acquisition Radar Review	8	6
Track Radar Review	8	3
Trouble Shooting	-	20
Orientation, Synchronization, and Trouble Shooting of the AAFCS M33	-	4
Review of Log Book and World Geographic Reference System	2	-
Field Adjustments Review	-	6
Electronic Countermeasures	2	2
Supply and Administrative Procedures	4	-
Care and Maintenance of the Generator	4	-
Heater, Lights, Battery, and Trouble Shooting Review	4	-
Brakes, Switchboard, and Trouble Shooting Review	4	-
Clutter and Coverage Diagrams and Trouble Shooting Review	4	-
Preventive Maintenance	4	-
Total	48	53

*Does not include 19 hours of nonacademic time: Commander's time, physical training, etc.

PRACTICAL EXERCISE

MARCH ORDER

PRELIMINARY TROUBLE: None.

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY:

1. Tool kits no. 1 and no. 2,
2. Track antenna installation kit,
3. Acquisition antenna installation kit,
4. Spanner wrench,
5. Striking hammer,
6. Four jack handles, and
7. Leveling sets for acquisition and track systems.

INSTRUCTOR'S NOTE: The first eight-hour segment of this exercise will consist of dismantling the system (with the exception of the permanently placed cables) and preparation for transport. The second eight-hour segment will consist of emplacing, leveling, and orienting the AAFCS M33.

LESSON PLAN

ACQUISITION RADAR REVIEW
(Part I)

OBJECTIVE:

To review the trouble shooting procedures and the function of the following, on a block level:

1. Pulse synchronizer,
2. Transmitter,
3. RF system, and
4. Receiver system.

INTRODUCTION:

This is the first of two lessons which will cover the acquisition radar on a block level. A review of the function of each unit should help the student to tie in the facts presented during the course. The trouble shooting procedures for each unit will be discussed.

PRESENTATION:

> INSTRUCTOR'S NOTE: Cover the subjects listed as completely as possible in the time allotted. Stress the trouble shooting procedures for each stage or channel.

1. Pulse Synchronizer (Characteristics).

   a. The synchronizer pulse is a 20 volt, 2-microsecond, positive pulse.

b. The preknock pulse is a 25 volt, 2-microsecond, positive pulse.

c. The test pulse is a 6 volt, 7- to 9-microsecond, positive pulse.

d. The pulse repetition rate is 1,000 pulses per second.

2. Acquisition Transmitter (Complete Block Diagram).

a. The trigger generator generates a pulse of sufficient amplitude to trigger the modulator. The trigger generator functions as follows.

1) Tube V1A amplifies the synchronizer pulse and applies it to blocking oscillator V1B.

2) Stage V1B is a single-swing blocking oscillator with a 230 volt, 5-microsecond, pulse output which is applied to V2.

3) Hydrogen thyratron V2 allows pulse-forming network Z1 to discharge through the pulse transformer.

4) Pulse-forming network Z1 charges to approximately twice the supply voltage.

5) Inductance L1 aids in the build-up of the charge on Z1.

6) The rapid discharge of Z1 through the primary of the pulse transformer results in a positive 3-microsecond pulse, approximately 600 volts in amplitude across the secondary.

7) Tube V3 is placed in the circuit to insure that Z1 starts its charge from the same reference on each charging cycle.

b. The modulator, located in the lower section of the acquisition antenna assembly, operates on the same basic principle as the trigger generator.

   1) Pulse-forming network Z6 charges to approximately twice the supply voltage.

   2) Hydrogen thyratron V4 acts as a switch to allow Z6 to discharge through the pulse transformer.

   3) Reverse-current thyratron V5 acts as a low-impedance path to ground for reverse current resulting from an impedance mismatch.

   4) Meter M1 indicates both the filament voltage of the hydrogen thyratron capsule and the reverse current.

c. Pulse transformer T1 steps up the 1.3-microsecond pulse to an amplitude of 38 to 45 kilovolts and applies it to the magnetron.

d. Acquisition magnetron V1 has a rated peak power of 1 megawatt operating with a frequency range of 3,100 to 3,500 megacycles.

   1) Magnetron tuning drive motor B2 changes the magnetron frequency by moving tuning slugs in or out of the cavities.

   2) Meter M1 indicates average magnetron current, while diodes V6 through V9 provide a current path to ground if any part of the metering circuit opens.

e. The acquisition high-voltage power supply provides the transmitter with 4 to 8 kilovolts direct current.

   1) The input to the power supply is 3-phase, 120 volt, 400-cycle power applied to saturable reactor L1.

2) The saturable reactor, by a DC control current, determines the magnitude of alternating current applied to high-voltage transformer T1.

3) The control current is obtained from selenium rectifier CR1, whose input is an AC voltage controlled by the VOLTAGE ADJ variac.

4) The secondary of the high-voltage transformer delivers the 3-phase AC to a 6-tube, full-wave, bridge-type rectifier.

5) The rectifier develops the high potential required for proper operation of the modulator section.

3. Acquisition RF System (Complete Block Diagram).

The RF system transfers and radiates the RF energy from the magnetron and receives and couples the return echo to the signal mixer.

a. The waveguide delivers the RF energy to the antenna and couples the return echo to the receiver.

b. The duplexer is a switching device that includes the Y-junction, one TR tube, and the two ATR tubes.

1) During the period when the magnetron is operating, the TR tube prevents the RF energy from entering the receiver.

2) The ATR tubes prevent the return echo from being absorbed by the magnetron.

c. The directional coupler samples a portion of the transmitted energy, making it possible to measure power frequency and standing-wave ratio.

d. The rotary joint changes the shape of the waveguide from rectangular to circular and allows the antenna to rotate on a fixed base while maintaining electrical continuity during rotation.

e. The pillbox radiator focuses the beam and feeds it to the bar reflector.

f. The bar reflector forms the RF energy into a needle, or cosecant, squared-beam pattern.

g. Elevation scanning is accomplished by injection of auxiliary reflector bars into the bar reflector assembly and tilting the complete assembly.

1) Power for movement of the bar reflector and the auxiliary bars if furnished by the hydraulic system which can tilt the reflector up to 9°.

2) Power is applied to the hydraulic-pump motor upon application of the acquisition radar power so that oil pressure is kept up all the time.

3) The nose of the beam may be tilted over a range of 20°, from +2° to +22°.

4) The corresponding reflector tilt is from 0° to +9°.

5) In automatic scanning, the beam traverses the 20° scan in approximately 20 seconds.

6) The ACQUISITION ELEVATION COVERAGE dials are calibrated in degrees, reading from +2° to +20°.

7) A reading of +20° on the ACQUISITION ELEVATION COVERAGE dials corresponds to a beam elevation of +22°.

h. The acquisition-antenna azimuth drive is a complete gearing system driven by a 4-horsepower motor.

1) The antenna can be rotated at 10, 20, and 30 rpm.

2) Solenoids are used to activate the correct motor winding for the desired speed.

4. Acquisition Receiver System.

a. Mixer Channel.

1) The preselector presents a low-impedance path to the transmitter frequency, attenuating all other frequencies.

a) The preselector is a cylindrical resonant cavity, tunable over the entire frequency range of the magnetron.

b) Maximum attenuation occurs at the image frequency.

2) The signal mixer mixes the local-oscillator output with the return echo and produces the intermediate frequency.

a) The RF echo is fed into the mixer by a matching iris in the waveguide.

b) Local-oscillator energy is introduced into the mixer by a coaxial cable.

c) Crystal CR2 detects the IF signal.

d) A concentric, polyiron core acts as an RF choke to filter the RF energy.

b. Local Oscillator.

1) The local oscillator (LO) is a reflex klystron with an external resonant cavity.

2) The local oscillator is tuned by varying:

a) The physical size of the resonant cavity, and

b) The negative repeller-plate voltage.

3) The output is fed to the signal mixer and the AFC mixer.

c. Local Oscillator Power Supply.

1) The LO power supply is located at the right rear of the acquisition RF coupler.

2) LO power supply uses a conventional full-wave rectifier.

3) Tubes V2 through V7 regulate the output voltages.

4) The output voltages are:

a) A -800 volt DC for use as a keep-alive voltage for the TR tube,

b) A -625 volt and -400 volt DC for use as repeller-plate voltage for the local-oscillator tube,

c) A -325 volt DC to the cathode of the local oscillator, and

d) A 6.3 volt AC to the local-oscillator tube, AFC unit, and IF preamplifier, for filament voltage.

d. The IF Preamplifier.

1) The IF preamplifier is mounted at the right side of the tuning-drive gear box in the acquisition RF coupler.

2) The first two stages are grounded grid triode amplifiers to reduce noise.

3) The final three stages are high-gain pentode amplifiers which are transformer coupled.

4) The IF preamplifier is given a broad bandpass by loading resistors across the coupling transformers.

5) The output is coupled by coaxial cable to the IF attenuator.

e. The IF Attenuator.

1) The IF attenuator matches the 75-ohm impedance of the cable from the IF preamplifier.

2) Attenuation is variable from 20 decibels to 40 decibels, in steps of 5 decibels.

f. The IF Amplifier Channel.

1) The first six stages are medium-gain circuits employing back bias to prevent overloading as a result of strong signals.

a) The back bias reduces clutter on the PPI's and is one of the antijam features of the receiver.

b) Broad-tuned transformers couple the signal between stages.

2) The seventh stage is a high-gain power amplifier.

3) The final stage is a dual diode which detects the signal to produce the negative bypass and the positive MTI video.

g. The MTI Modulator Channel.

1) The moving-target indicator (MTI) modulator channel receives the positive MTI video and the preknock pulse.

2) The test pulse is used to aline the MTI circuits and does not enter the modulator channel under normal operating conditions.

3) A 15-megacycle carrier is generated and modulated by the positive MTI video and the negative preknock pulse.

4) The output is fed to the MTI delay and nondelay channels.

h. Nondelay Channel.

1) Video from the MTI modulator undergoes approximately 65 decibels of attenuation.

2) The signal is then amplified by four stages of voltage amplification and one stage of power amplification.

3) Crystals CR1 and CR2 detect the output.

4) The output rides at a positive, 4 volt level.

a) The output level is equal in amplitude and opposite in polarity to the output level of the delay channel.

b) Should a difference occur between the two levels, a voltage is fed through the nondelay AGC amplifier to vary the gain of the nondelay channel so that the two DC levels are equal.

i. Delay Channel.

1) The delay line delays the signal from the MTI modulator channel 1,000 microseconds and attenuates it 60 decibels.

2) The signal is amplified and fed through a cathode follower, for impedance matching purposes, to the 0- to 20-decibel attenuator.

3) The 0- to 20-decibel attenuator provides a means for maintaining the output amplitude of the delay and non-delay channels equally.

4) The signal then undergoes four stages of voltage amplification followed by one stage of power amplification.

5) Crystals CR1 and CR2 detect the signal.

6) The output, riding at the negative, 4 volt level, is fed to the autosynchronizer channel and delay line Z1.

a) Delay line Z1 provides a means for adjusting the time relationship of the signal from the delay and nondelay channels.

b) Should the 4 volt level change, the output of the delay AGC amplifier causes the gain of the delay amplifier to change, keeping the 4 volt level.

j. Autosynchronizer Channel.

1) The negative video is eliminated, and the positive preknock pulse is passed through the channel.

2) Three stages are used to shape the pulse.

3) The output is the autosynchronizer pulse which triggers the synchronizer so that action in the transmitter and sweep circuits is initiated at concurrent intervals.

k. The MTI Video Channel.

1) Delay and nondelay video are compared across a resistive network at the input.

2) Echoes from fixed targets cancel while the moving target video does not cancel.

3) The circuit is arranged so that the output will always be negative.

4) The negative MTI video is sent to the switcher-mixer channel.

1. Switcher-Mixer Channel.

1) The switcher-mixer channel receives as inputs the preknock pulse, bypass video, MTI video, and IFF video.

2) The preknock pulse starts a multivibrator whose output gates the switch tubes allowing either the MTI or bypass video to appear on the PPI's

INSTRUCTOR'S NOTE: In newer systems, a phantastron replaces the multivibrator.

3) The range of the MTI presentation is dependent on the bias of the multivibrator which is controlled by the operator.

a) When the multivibrator tubes reverse operation, MTI video is replaced by the bypass video.

b) The MTI switch when in the OFF position removes the bias voltage to the multivibrator, rendering it inoperative; and only the bypass video appears on the PPI's.

4) The IFF information is mixed with the video at the output of the switcher mixer.

5) The output video is sent to the video and mark channel.

m. Video and Mark Channel.

1) The positive video input passes through one stage of amplification and inversion.

2) The video and marks are mixed at the input network to the final stage.

3) The output is sent to the PPI and precision indicators each of which includes its own video amplifier.

n. The AFC Channel.

1) The automatic frequency control (AFC) mixer mixes the local oscillator output with a sample of the transmitted pulse to produce an intermediate frequency.

2) Should the intermediate frequency deviate from 60 megacycles, a voltage is developed that causes the tuning motor to drive, altering the local oscillator frequency so that the intermediate frequency returns to 60 megacycles.

a) When a change in frequency occurs, a discriminator develops a series of pulses at its output.

b) The pulse stretcher converts the pulses to a DC voltage.

c) The DC voltage is fed to the modulator which has a 400-cycle output when a DC input is received.

d) The phase and amplitude of the 400-cycle output correspond to the polarity and magnitude of the DC input.

e) The 400-cycle voltage, amplified by the low-power servo amplifier (LPSA), causes the tuning motor to turn in a direction determined by the phase of the signal.

3) If the intermediate frequency is out of the bandpass of the IF amplifier, the autosearch circuits take control.

   a) Relay circuits apply a DC voltage to the modulator causing the local oscillator to tune through its frequency range.

   b) With the DC voltage applied to the modulator, circuit action is the same as for slight frequency variations.

o. The Sensitivity Time Control (STC) Channel.

1) The preknock input initiates the action of multivibrator V1.

2) The multivibrator output is applied through cathode follower V2A, CR4, and CR1 to cathode follower V3A.

3) A capacitor in the input circuit to V3A causes the pulse to have a sloping trailing edge.

4) The signal is amplified by V2B and presented to cathode follower V3B.

5) The output of V3B, a negative waveshape riding on a DC level determined by the ACQUISITION RECEIVER GAIN control, is delivered to the last three stages of the IF preamplifier where it is used to control the gain of the ACQ receiver for close targets.

LESSON PLAN

ACQUISITION RADAR REVIEW
(Part II)

OBJECTIVE:

To review the function and trouble shooting procedures to the block level of the:

1. Presentation system,
2. Designation control system, and
3. Target designator.

INTRODUCTION:

This lesson will conclude the review of the acquisition radar. A thorough understanding of the function of the units discussed will facilitate trouble shooting and adjustments.

PRESENTATION:

INSTRUCTOR'S NOTE: Cover the function of each unit as completely as possible in the time allotted. Stress trouble shooting.

1. Acquisition Presentation System (Detailed Block Diagram).
   a. The sweeps on the PPI's may display 60, 000 or 120, 000 yards of range.
      1) The two PPI's are identical and interchangeable.
      2) The sweeps start from the center of the PPI tube and progress to the outer edge.

3) The sweep is initiated by the preknock pulse.

4) Sweep rotation is synchronized with the acquisition antenna.

b. The 4-kilocycle oscillator produces a signal which is applied to the acquisition-azimuth resolver and one of the line-slew resolvers in addition to being used as a reference voltage.

1) Tube V1 is a push-pull oscillator that generates a constant-amplitude, 4-kilocycle signal.

2) Push-pull power amplifiers V2 and V3 isolate the load from V1.

c. The acquisition-azimuth resolver B2 is located in the antenna drive unit of the acquisition antenna assembly.

1) To rotate the sweeps of the PPI's, it is necessary to have an electrical signal that corresponds to the mechanical position of the antenna.

2) The rotor of the resolver is geared directly to the antenna.

3) The acquisition-azimuth resolver converts the constant-amplitude, 4-kilocycle input into an output whose amplitude will vary with the changing azimuth of the antenna.

4) Since there are two stator windings physically displaced by 90°, signals are developed at the output with a 90° phase difference.

d. The modulated, 4-kilocycle signal from the resolver is amplified by the resolver amplifier.

1) The resolver amplifier isolates the resolver from its loads.

2) The amplifier consists of two identical channels.

3) The N-S signal is amplified by V1 and V2, and the E-W signal is amplified by V3 and V4.

4) The gain of each channel is approximately one.

5) The output is fed to the track-azimuth resolver, the azimuth-line resolver, and the demodulators of each PPI unit.

e. There are two demodulators for each plan position indicator.

1) All demodulators are interchangeable with each other.

2) The two inputs to the ring demodulator V1 and V2 are the modulated, 4-kilocycle signal from the resolver amplifier and the constant-amplitude, 4-kilocycle carrier from the 4-kilocycle oscillator.

3) Tubes V1 and V2 detect the envelope from the modulated 4-kilocycle signal and provide two signals 180° out of phase with each other.

4) The 4-kilocycle component is filtered by RC networks in the input circuit to the cathode followers.

5) The two outputs ride at a positive DC level and vary in amplitude from +3 to +30 volts.

f. The two sweep-generator chassis, one for each PPI, are identical and interchangeable (Fig. 7-9).[3/]

1) Each chassis contains four sweep-generator circuits, one for each sweep voltage: north, south, east, and west.

2) Each circuit is identical.

3/ Figures are direct references to figures in the AAFCS M33 Schematics.

3) When gated by the range gate, these stages produce four trapezoidal voltages.

4) The amplitude of each sweep voltage is determined by the instantaneous amplitude of the associated input from the demodulators.

5) The input amplitude varies in accordance with the changing azimuth of the acquisition antenna.

g. Since the output amplitude of the sweep generator is very low, the sweep amplifiers amplify the sweep signals to a level great enough to obtain proper deflection of the electron beam.

1) There are two sweep-amplifier chassis for each PPI.

2) Each chassis contains two identical channels.

3) The inputs are 180° out of phase, and the two amplifiers feeding the two ends of the deflection coil are operating in push-pull.

a) Voltage amplifiers V1 and V2 increase the amplitude of the sweep voltage to a level great enough to operate V4.

b) Tube V3B causes each sweep to start at the same point.

c) Power amplifier V4 is employed to supply the large amount of current needed for electromagnetic deflection.

d) Negative feedback from V4 and V1 is used to insure linearity.

e) The trapezoidal voltage produces a sawtooth of current through the deflection coil.

f) Stages V5, V6, V3A, and V7 function exactly like V1, V2, V3B, and V4, respectively.

h. The range gate and the intensity limiter gate the sweep generator and unblank the PPI during sweep time.

1) This channel is located on the video amplifier chassis of each PPI unit.

2) Tube V1 is a cathode-coupled, one-shot multivibrator, triggered by the preknock pulse.

3) The output-pulse width is controlled by the RANGE SELECTOR switch on the face of the PPI.

4) The RANGE SELECTOR switch controls the amount of capacity in the grid circuit of V1B thus controlling the time V1B is cut off.

5) Tube V2A speeds the action of the multivibrator increasing the sharpness of the leading and trailing edges.

6) Two positive outputs are taken from the plate of V1B.

7) One output, the intensity gate, is coupled to the grid of the 10KP7 PPI tube.

8) The amplitude of the unblanking gate is controlled by the limiter V2B and the intensity control.

9) The other output taken from V1B is applied to the control grid of V3B across clamper V3A.

10) Tube V3A clamps the signal so that its positive excursion never exceeds +1 volt.

11) Since the gate starts at approximately -74 volts, cutoff limiting occurs in the control grid circuit of V3B.

12) The output of cathode follower V3B, approximately +2 volts, is fed to the sweep generators.

13) The width of this gate pulse controls the slope of the sweep voltage that is generated in the sweep generator.

14) The length of the sweep on the PPI tube is determined by the amplitude of the sweep voltage; and, since the amplitude in either range position remains the same, the sweep length does not change.

15) Since the slope is longer in the 120, 000-yard position, it will take a longer period of time for the sweep to traverse from the center of the scope to the edge.

i. The indicator high-voltage power supply provides all the necessary high potentials for the PPI, PI, trial-fire indicator, and the tracking indicators.

1) Tubes V1 and V2 make up a conventional voltage doubler.

2) The output of V1 and V2 is +8.5 kilovolts.

3) A +5 kv is tapped off a voltage divider that is across the voltage doubler.

4) Tube V3 is a half-wave rectifier giving a positive, 2, 000 volt output.

5) Tube V4 is a half-wave rectifier connected in reverse of V3, thus providing a -2, 000 volt output.

2. Designation Control System (Detailed Block Diagram).

a. The line-slew resolvers control the position of the steady steerable azimuth line.

1) The 4-kilocycle line signal is fed into the line-slew resolver at the tactical control console.

2) The steady, steerable, azimuth line will appear at the resultant setting of both line slew resolvers.

3) The output of the line-slew resolvers is fed to both PPI's and is applied to the demodulators when the associated RING DEPRESS switch is activated.

b. The line resolvers control the position of the flashing azimuth line.

1) The modulated, 4-kilocycle signal from the acquisition-azimuth resolver is applied to the line resolver at the tracking console.

2) The output hits a null point when the acquisition antenna rotates to a point equal to the sum of the angular displacement of the two line resolvers.

3) A second null point will occur when there is a 180-degree difference between the acquisiton antenna and the sum of the line resolvers.

4) The output is fed to the acquisition-mark generator and to the azimuth-sweep channel of the precision indicator.

c. The track-azimuth resolver controls the position of the electronic cross in the azimuth.

1) This resolver is geared to the track antenna.

2) The input is a modulated, 4 kilocycles from the acquisition azimuth resolver.

3) The output voltages indicate the azimuth of the acquisition antenna, minus the azimuth of the track antenna, + 180 degrees.

4) When the two antennas have the same angular displacement, the E-W output will be zero.

5) The output will also hit a null point when there is a 180-degree difference between the azimuth of the two resolvers.

6) The output is fed to the track-mark generator and the azimuth-sweep channel of the precision indicator.

d. The track- and acquisition-mark generators are identical and interchangeable, and only the track-mark generator will be discussed.

1) The N-S signal and the 4-kilocycle carrier are mixed across R20 and fed to amplifier V3A.

2) The N-S signal undergoes a 180-degree phase shift on the second half of the acquisition antenna rotation.

a) When the two signals are in phase, they will add.

b) When the two signals are out of phase, they will subtract.

3) Only one null point will occur at the grid of V3A for each rotation of the acquisition antenna.

4) The output of V3A, varying at the rate of the acquisition antenna rotation, is fed to the 0.8-degree and 40-degree detectors.

5) The E-W signal is applied to V1A.

6) The output of V1A, as a result of limiting action, is constant except at the null points.

7) The limiting action of V1A limits the signal to a point where the null dip corresponds to 40° of antenna revolution.

8) V4 detects the 40-degree dip and clips a portion of the positive half of the input from V3A.

9) The null points ride on the sine wave at the cathode of V3B.

10) The input stage of the mixer channel is biased so that only 30° of the null waveshape, riding on the positive half of the sine wave, is used.

11) The 0.8-degree limiter further limits the 40-degree null.

12) The 0.8-degree detector detects the null and clips a portion of the positive half of the sine wave.

13) The output is fed to the suppressor grid of the coincidence tube V7.

14) The preknock pulse is applied to the control grid and will be developed in the plate circuit only for the period the 0.8-degree null is riding on the positive portion of the sine wave.

15) During the time of the 0.8-degree null, many preknock pulses will be applied to V6.

16) The purpose of V6 is to trigger V5 only once during the time of the 0.8-degree null.

17) V5 generates the 735-microsecond, azimuth mark that will eventually appear as the radial line of the electronic cross.

18) The mark output of the acquisition-mark generator will appear as the flashing azimuth line.

e. The purpose of the acquisition-range control channel is to provide control of the range circle and the acquisition-range gate from either the tracking console or tactical control console (TCC).

1) The acquisition range is controlled by the setting of the range pot R6.

2) The output of the control transformer B11 is zero when the angular difference of the two resolvers is zero.

3) When K11 is de-energized, control of the acquisition range is at the tracking console.

4) When K11 is energized, control is at the TCC.

5) If the tracking console has control and its handwheel is turned, the settings of the range pot and rotor of the control transformer change position because of the direct gearing.

a) Since the two resolvers are not in coincidence at this time, a 400-cycle output is applied from B11 through the range coupling network to R_q, the LPSA.

b) The output of R_q is fed through contacts of K11 to motor tachometer B2.

c) B2 changes the position of the rotor of 31 until it is in coincidence with the rotor B11.

6) When control is at the TCC and its handwheel is turned, the rotor of B1 is displaced.

a) B11 will have a 400-cycle output fed to R_q.

b) The output of R_q is fed, through contacts of K11, to motor tachometer B12.

c) B12 changes the setting of the range pot and the rotor of B11 until there is no output from B11, at which time circuit action ceases.

f. The acquisition-range channel generates the acquisition-range mark and the acquisition-range gate.

1) The acquisition-range mark appears as the range circle on the PPI.

2) The acquisition-range gate is used to gate the range sweep of the precision indicator.

3) Clamper V1B holds the plate voltage of the phantastron at the setting of the range pot.

4) Isolation diode V1A prevents the phantastron current variations from entering the preknock distribution circuits.

5) The leading edge of the negative phantastron output occurs at preknock time.

6) The trailing edge will occur at a time determined by the setting of the range pot.

7) The phantastron pulse is differentiated in the grid circuit of V3B.

8) The negative pip, corresponding to the trailing edge of the output from V2, triggers the gate multivibrator V4.

9) Cathode follower V5B matches the impedance of the coaxial cable which is used to convey the positive, 30-microsecond range gate.

10) The positive gate is applied to V5A bringing it out of cutoff.

11) When V5A conducts, Z1, the 15-microsecond, quarter-cycle oscillator, conducts.

12) The resulting negative waveshape at the grid of V6A causes it to cut off; and the output is a positive waveshape, flat on top with a slight slope on the trailing edge.

13) V6B incorporates saturation limiting, and its output is a reasonably good, negative, square wave.

14) The output of V6B is differentiated in the input circuit of V7.

15) The negative pip at the grid of V7 is cutoff because the tube is biased very near cutoff.

16) The output of V7, a negative pip, occurs 15 microseconds after the leading edge of the range gate.

17) Transformer T2 inverts the negative 0.5-microsecond pip and feeds it to the acquisition-range mark distribution.

3. Target Designator (Detailed Block Diagram).

a. The mixer channel has six inputs.

1) The acquisition-range mark appears as the range circle.

2) The acquisition-azimuth mark appears as the flashing azimuth line.

3) The track-range mark appears as the arc portion of the electronic cross.

4) The track-azimuth gate allows the arc portion of the electronic cross to appear for 10 degrees.

5) The track-azimuth mark appears as the radial line of the electronic cross.

6) The track-range gate allows the radial line to appear for 5, 000 yards.

7) The gated marks are mixed with video in the video and mark mixer channel and presented to the PPI and precision indicators.

b. The mixer channel forms a part of the video and mark mixer chassis.

1) Arc coincidence tube V1 receives the track-range mark and the track-azimuth gate.

a) V1 is allowed to conduct for a 10-degree portion of the track-azimuth gate.

b) The acquisition track range mark (QTRMK) is passed during the conduction time of V1.

2) Radial-line-coincidence tube V2 is presented with the track-azimuth mark and the track-range gate.

a) The track-range gate allows V2 to conduct for a period corresponding to 5, 000 yards.

b) Part of the track-azimuth mark is passed during the conduction period of V2.

3) Clipper amplifier V3 mixes the gated QTRMK and the gated track-azimuth mark (TAMK) and presents them to V4.

4) Amplifier V4 mixes the QTRMK and the TAMK with the acquisition-range mark (QRMK) and the acquisition azimuth mark (QAMK).

5) Clipper amplifier V6 keeps the marks and their intersections from attaining an amplitude that would cause blossoming of the PPI's.

6) The marks are mixed with the video in the grid circuit of V7 and presented to the video amplifiers of the PPI and precision indicators.

c. The range-sweep channel is gated by either the track- or acquisition-range gate to produce the vertical range sweep.

1) When the TRACK-ACQ switch is in the ACQ position, the acquisition-range gate is applied to V1A.

a) V1A is cut off during the time of the gate, allowing a capacitor to charge.

b) The sharp leading edge of the gate is applied to the grid of V2 along with the charge on the capacitor resulting in a trapezoidal waveshape.

c) The output of V2 is a negative, trapezoidal waveshape with a sharp spike on the leading edge caused by the feedback circuit of V4 and V5.

d) V3 amplifies the signal to bring it up to the proper level for power amplification.

e) Clamper V1B insures the starting of each sweep from the same level.

f) Power amplifiers V4 and V5 are connected in parallel to provide enough current to deflect the electron beam from the bottom to the top of the cathode-ray tube (CRT).

2) When the TRACK-ACQ switch is in the TRACK position, circuit action is the same except that the track-range gate replaces the acquisition-range gate.

d. The azimuth-sweep channel causes the electron beam to be deflected from the left edge to the right edge of the cathode-ray tube during the azimuth gate.

1) When the TRACK-ACQ switch is in the TRACK position, the E-W signal from the track resolver is applied to the azimuth-sweep channel.

2) When the TRACK-ACQ switch is in the ACQ position, the designated E-W signal from the TCC line resolver is applied to the azimuth-sweep channel.

3) The 4-kilocycle carrier is always applied to the azimuth channel.

4) The ring demodulator composed of V1 and V2 works exactly like the ring demodulators of the PPI.

5) Limiters V3A and V3B clip most of the positive portion of the input to V4 and V5.

6) V4 and V5 use cut off limiting so that the plate waveforms of V4 and V5 are squared off on both the positive and negative excursions.

7) The electron beam will be deflected only when the magnetic field set up by the deflection coil is expanding or contracting.

8) The magnetic field will vary only when the current through the deflection coil is fluctuating.

9) The current through the deflection coil will change in magnitude during the slope between the positive and nagative excursions and the extreme negative and positive portions of the signal at the plates of V4 and V5.

10) During normal operation, the electron beam will be deflected from left to right with the PI blanked during the portion in which the electron beam would sweep from right to left.

e. The unblanking channel serves to intensify the sweeps during the period that the range gate and the azimuth gate are in coincidence.

1) The acquisition-range gate and the acquisition-azimuth gate will be applied when the TRACK-ACQ switch is in the ACQ position.

2) The track-range gate and the track-azimuth gate will be applied when the TRACK-ACQ switch is in the TRACK position.

3) V3A and V3B work together to produce a series of positive, 30-microsecond pulses.

4) The positive pulses will be applied to the control grid of the cathode-ray tube only when both V3A and V3B are cut off.

5) Both triodes are cut off when range gate pulses occur during the azimuth gate.

LESSON PLAN

TRACK REVIEW
(Part I)

OBJECTIVE:

To furnish the student with a review of the material and the trouble shooting methods covered in the track section of this course.

INTRODUCTION:

This is the first of two lessons which will review the block-level operation of the tracking radar system. Trouble shooting will be faster and more efficient when the student has a thorough knowledge of the over-all operation of the track radar. It is essential that the relation between the various units of the track radar be understood. The function of the track radar with respect to the rest of the AAFCS M33 system will also be covered.

PRESENTATION:

1. Track Transmitter.

   a. Trigger Generator.

      1) The trigger generator receives the 20 volt, 2-microsecond, synchronizer pulse.

      2) A 460 volt, 4-microsecond pulse is developed by the single-swing blocking oscillator V1B and applied to the grid of a cathode follower.

      3) The trigger pulse of 450 volt amplitude and 4-microsecond duration can be monitored at TP2. It is sent to the grid of the switch tube in the modulator.

4) Frequent troubles.

a) Oscillator V1 bad.

b) No synchronizer pulse.

b. Modulator.

1) The 450 volt pulse applied to the grid of the switch tube V1/A2 drives the tube into conduction.

2) Pulse-forming network Z1 discharges as the switch tube fires.

3) When the pulse-forming network has been charged to approximately twice the input DC voltage, the switch tube fires.

4) The pulse-forming network discharges through the primary of the pulse transformer T3.

5) A negative-going pulse is induced into the cathode circuit of the magnetron. The amplitude of the negative-going pulse is determined by the amplitude of the DC high voltage applied to the modulator.

6) Frequent troubles.

a) Switch tube V1/A2 bad.

b) Pulse transformer T3/D7 shorted. (Look for bulged sides.)

c. Magnetron and RF Section.

1) A negative-going pulse, .25 microseconds in duration, is applied to the cathode of the magnetron through pulse transformer T3.

2) The magnetron oscillates for the duration of the negative pulse.

3) A pulse of RF energy leaves the magnetron and follows the waveguide to the TR tube.

4) At this time, both the ATR and the TR tubes are ionized. The two ATR tubes will not affect the passage of RF, but the TR will prevent transmitted energy from reaching the receiver.

5) The two ATR tubes prevent the echo return signal from entering the magnetron and allow the received signal to reach the receiver.

6) Frequent troubles.

a) Either C5 or C6 in the cathode circuit of the magnetron shorted. (Look for charred insulation on L1A/D7 and L1B/D7.)

b) Magnetron not oscillating. (Check with the hand in front of the scanner horn or with the neon bulb from the AFC unit.)

c) Bad TR tube. (Suspect this if the signal-mixer crystals keep blowing.)

2. Track Receiver System.

a. Balanced Converter, IF Preamplifier, IF Amplifier, Video Amplifier, and Video and Notch Mixer.

1) The received signals are mixed with the output of the local oscillator in the signal mixer.

2) The local-oscillator output is compared with a sample of the transmitted pulse in the AFC mixer. The output is known as the AFC IF and is used to control the operation of the AFC channel.

3) The output of the signal mixer is known as the signal IF and is sent to the track preamplifier where it is amplified preparatory to sending it through the slip-ring assembly to the rest of the receiver (located in the radar cabinet).

4) The signal IF is sent to an attenuator which is used to compensate for tube aging in the receiver. The signal IF is then passed to the IF amplifier where it is further amplified and then detected.

5) The video output of the IF amplifier is sent to voltage amplifier V19 and a pair of parallel power amplifiers V20 and V21.

6) The output of the parallel power amplifiers is applied to the video and notch mixer where the 100-yard notch is superimposed on the video signal.

7) From the video and notch mixer, the track video and 100-yard notch are sent to the three track indicators.

8) The AFC channel receives the AFC IF and generates a control voltage which depends in value on whether the IF is above or below 60 megacycles.

   a) If the IF is below 60 megacycles, the control voltage will be -30 volts. This voltage is applied to the local oscillator and causes it to tune up in frequency.

   b) If the AFC is above 60 megacycles, the control voltage will be +15 volts.

   c) The action of the AFC channel will be to keep the local oscillator tuned to 60 megacycles above the transmitter frequency.

9) Frequent troubles.

a) Bad crystal in either signal mixer or AFC mixer.

b) Bad stage in IF preamplifier.

c) Broken cable between IF preamplifier and IF amplifier.

d) Bad stage in IF amplifier.

e) Bad stage in video amplifier. (Use test amplifier to check the operation of V19, V20, and V21.)

f) Video and notch mixer V7 bad. (Use test amplifier in order to check operation.)

g) Extreme temperature changes will cause incorrect operation of the AFC section.

INSTRUCTOR'S NOTE: After the operation of the track receiver has been reviewed up to V7 (video and notch mixer), use the lesson plan on the track indicators in Volume IV as a guide in the review of these units. Start a discussion on the trouble-visual-indication basis for the remainder of the period.

LESSON PLAN

TRACK REVIEW
(Part II)

OBJECTIVE:

To review the material covered in the track radar section of this course (see Volume IV).

INTRODUCTION:

This is the concluding lesson devoted to the block-level operation of the tracking radar system. Any questions should be cleared up at this point.

PRESENTATION:

1. Use the lesson plan "Range Tracking System (Part II)" as a guide for the discussion of the track-range computer. Stress the time relationships of all the marks and gates used in the range computer.

2. Review the primary purpose of the range computer; namely, to furnish the computer with a voltage D_O representing slant range.

3. Discuss the operation of the pulse generator, using the lesson plan "Range Tracking System (Part VI)" as a guide.

4. Review the operation of the range-error channel and range servo, using the corresponding lesson plans.

5. Review the operation of the azimuth and elevation servos, lobing-error channel, and angle detectors.

6. In all cases stress trouble shooting procedure in the presentation, along with simple explanations of the respective units. Begin a symptom vs. trouble discussion whenever possible.

IM-5

LESSON PLAN

ORIENTATION, SYNCHRONIZATION, AND TROUBLE SHOOTING OF THE AAFCS M33

OBJECTIVE:

1. To present the techniques and procedures for orienting and synchronizing the AAFCS M33, and

2. To develop trouble shooting techniques.

INTRODUCTION:

The importance of accurate preparation of air defense materiel prior to firing cannot be overemphasized. With modern, high-flying, high-speed aircraft, the fire control problem becomes highly complex. Therefore at the outset of an engagement it is essential that all firing information be as accurate as possible. This accuracy can be accomplished by proper orientation and synchronization of the AAFCS M33.

PRESENTATION:

INSTRUCTOR'S NOTE: Use TM 9-6092-1-1, or volume I for detailed explanation.

1. Explanation and Demonstration.

   a. Preparation For Orientation:

      1) Emplacement,

      2) Communication,

      3) Leveling, and

      4) Energizing.

b. Check Collimation.

1) Check line-of-sight of the radar beam.

2) A moving object should be used for this operation.

2. Orientation.

a. Make dials read the same as where the equipment is pointing.

b. Orient the tracking radar in azimuth, and check elevation.

c. Orient the acquisition radar in azimuth.

3. Methods of Orientation.

a. Known Datum Point (KDP).

1) Choose a distant point (5,000-yard minimum range).

2) Azimuth of this point should be known either by survey or map.

3) Orientation of track radar.

a) Adjust AZIMUTH DATA CONVERTER dial (Plate 1).

b) Check ELEVATION DATA CONVERTER dial (Plate 2).

c) These dials must be adjusted to the azimuth and elevation reading of the KDP.

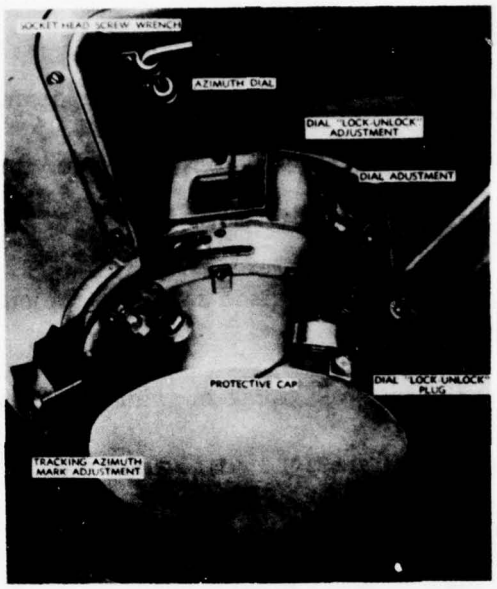


Plate 1. Track radar azimuth data converter (orient dial adjust and clutch release with protective caps removed).

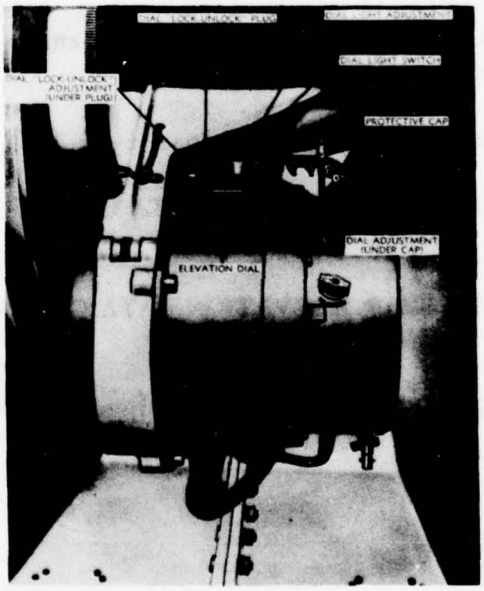


Plate 2. Elevation drive (showing elevation data converter).

4) Orientation of the acquisition radar.

a) Adjust the ACQUISITION AZIMUTH dial (Plate 3).

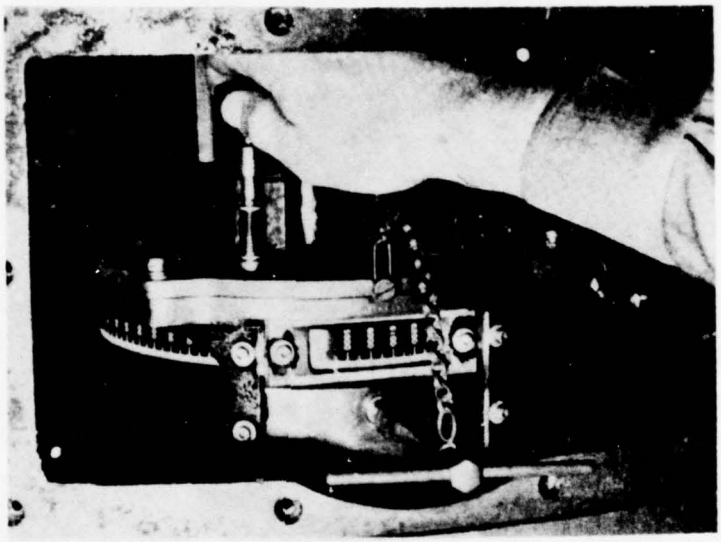


Plate 3. Orient compartment in the acquisition antenna drive (showing T-wrench placed on dial lock and azimuth adjustment being made with dial adjust).

b) Adjust the ANTENNA REFERENCE indicator of the acquisition antenna.

c) The dials are adjusted to show the azimuth of the KDP.

b. Backsight.

1) Suitable orienting instrument (Plate 4).

2) Orientation of the track radar.

a) Adjust the data converter to read back the azimuth of the orienting instrument.

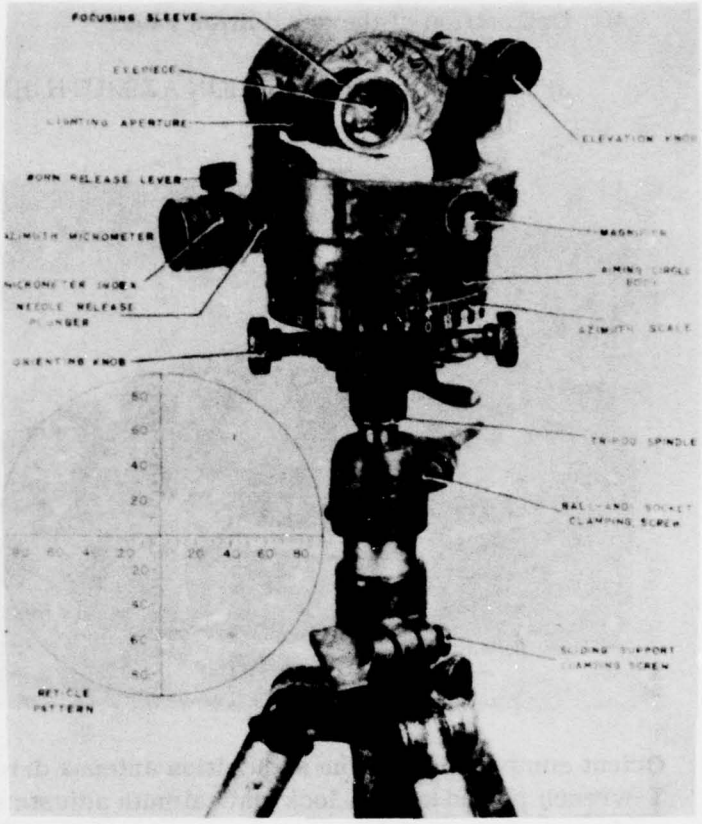


Plate 4. Aiming circle.

b) Check to see that the ELEVATION DATA CONVERTER dial reading is equal and opposite in sign to elevation of orienting instrument.

3) Orientation of the acquisition radar.

Adjust the ACQUISITION dial to read the same as the orienting instrument.

c. All the methods can be combined into one method.

1) Orient the track radar on KDP or a celestial body.

2) Backsight other battery elements on the track radar.

4. Synchronization.

   a. Adjust output indicators of the data transmission system accurately so that they give the same data as input indicators.

      1) The AAFCS M33 is automatically synchronized when the system is properly oriented.

      2) Compare data-converter reading with firing-servo reading.

   b. Adjust output indicator to agree with input information.

5. Check For Orientation and Synchronization.

   a. Lock on ground target.

   b. Track aerial target (automatic).

   c. Track aerial target (manually).

INSTRUCTOR'S NOTE: This period on trouble shooting is for the purpose of student review on troubles and trouble shooting techniques. It is suggested that the instructor proceed according to the subject matter presented in volume V.

6. Trouble Shooting Review.

   a. Use the material from the lesson plans in volume V on:

      1) Computer functional block,

      2) Associated circuits, and

      3) Observed target coordinates.

b. Troubles from this section should be given in order of their need for replacement or repair.

7. Suggested Troubles:

	Symptom	Fig. No.	Trouble
1.	AMPLIFIER UNBALANCE lamps will blink.	20-2	Place bad V2 or V4 in any DC amplifier.
2.	AMPLIFIER UNBALANCE lamps will not blink.	20-4	Place bad V1 in AZS unit.
3.	AMPLIFIER UNBALANCE lamps will not blink.	20-4	Place paper between contacts of UNBALANCE switch.
4.	Servo will not move.	20-6	Place bad V1 in any LPSA.
5.	Appropriate servo will not turn.	20-5	Place bad V3 or V6 in modulator.
6.	All servos oscillate.	23-15	Remove terminal no. 5 or E96.
7.	Plotting board will plot only in the third quadrant.	21-2	Remove terminal no. 487.
8.	Altitude plotting board at 0. ELEVATION dial at 0.	21-2	Remove terminal no. 50.
9.	No movement in servo.	22-2 to 22-5	Remove excitation at any servo motor.

LESSON PLAN

REVIEW OF LOG BOOK AND WORLD GEOGRAPHIC REFERENCE SYSTEM

OBJECTIVE:

1. To present a review on the use of the log book, and

2. To present an explanation of the World Georgraphic Reference System.

TRAINING AID:

Log sheets (weekly and monthly).

INTRODUCTION:

1. Before firing begins, the fire control system must be accurate and precise. The log book is the means of accomplishing this requirement. It is essential that the proper entries be placed in the log book. The use of the log book is of prime importance to a maintenance man.

2. The World Georgraphic Reference System is a grid reference system which basically defines a geographic area. This system is used mainly on the long-range plotting board; however, it can be placed on the radar PPI's. This system divides the earth's surface into quadrangles formed by meridians of longitude and parallels of latitude. The maintenance man will not be responsible for work concerning this system, except that he may be given a class on it. A knowledge of this system will enable him to have a better idea of what is going on in the battery.

IM-6

PRESENTATION:

1. Log Book.

INSTRUCTOR'S NOTE: Hand out log sheets to students.

a. Weekly Checks for the Complete System.

1) Acquisition range computer.

2) Elevation angle det balance.

3) Azimuth angle det balance.

4) Plotting board tests.

5) Storage batteries.

6) High-power servo balance.

7) Radar servo checks.

8) Servo preamplifiers balance.

a) Azimuth preamplifier balance.

b) Elevation preamplifier balance.

c) Range balance (1).

d) Range balance (2).

b. Monthly Checks for the Complete System.

1) Air filters and acquisition antenna assembly blower.

2) Horizontal prediction.

3) Parallax correction.

4) Wind azimuth correction.

5) Computer dynamic operation.

6) Target rate test.

7) Dead time test.

8) Static tests—normal ballistic conditions.

9) Static tests—various ballistic conditions.

c. The log book is a permanent record of all activities and repairs to the system.

2. The World Georgraphic Reference System Identification Code.

a. The GEOREF system uses an identification code which is separated into main divisions. The identification code designating the divisions is easy to remember. GEOREF designations are read the same as military grid coordinates. Follow the rule: Read right and up.

b. The three main divisions of the identification code and their identifying symbols are:

1) First division (Diagram 1).

a) Longitudinal. There are 24 longitudinal zones of 15 degrees each. These zones are lettered A through Z (omitting I and O) eastward from the 180th meridian. The first letter in any GEOREF designation signifies in which of these longitudinal zones the point is located.

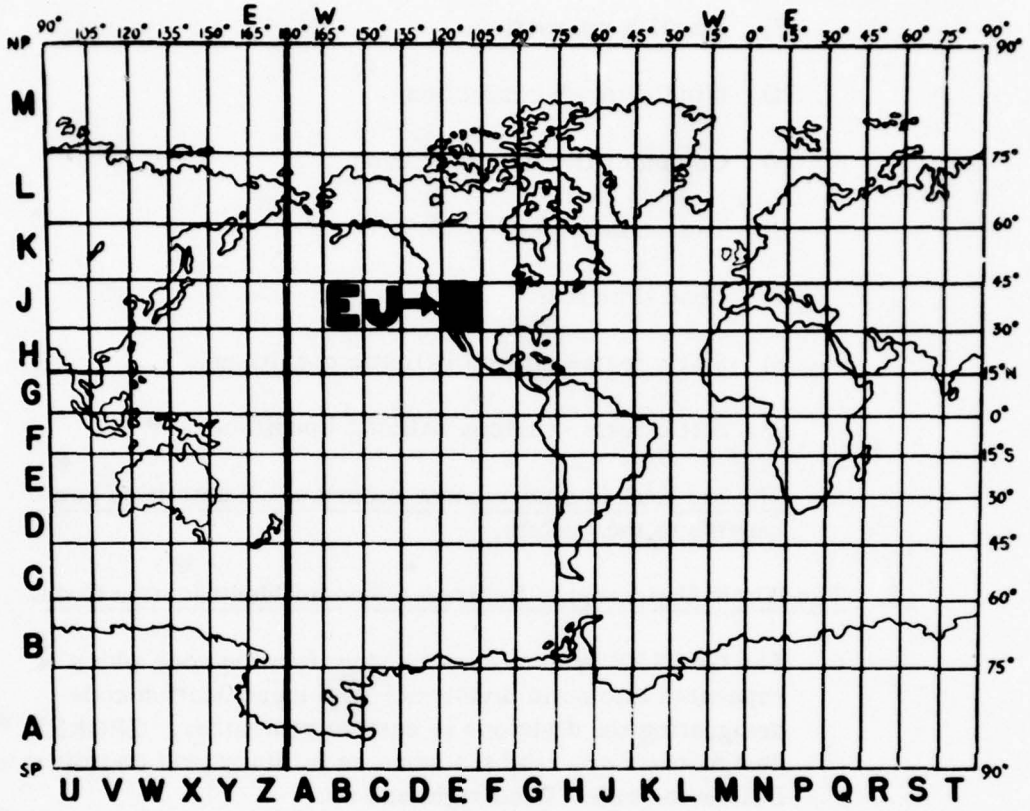


Diagram 1. GEOREF (first division).

b) Latitudinal. There are 12 bands of latitude, each 15 degrees wide, lettered A through M (omitting I) northward from the South Pole. The second letter in any GEOREF reference signifies the latitudinal band in which the point is located.

c) The zones of longitude, with the bands of latitude superimposed thereon, divide the earth's surface into 288 basic 15-degree quadrangles, each identified by two letters. Thus, the 15-degree quadrangle inclosing the southwest section of the United States is EJ.

2) Second division (Diagram 2).

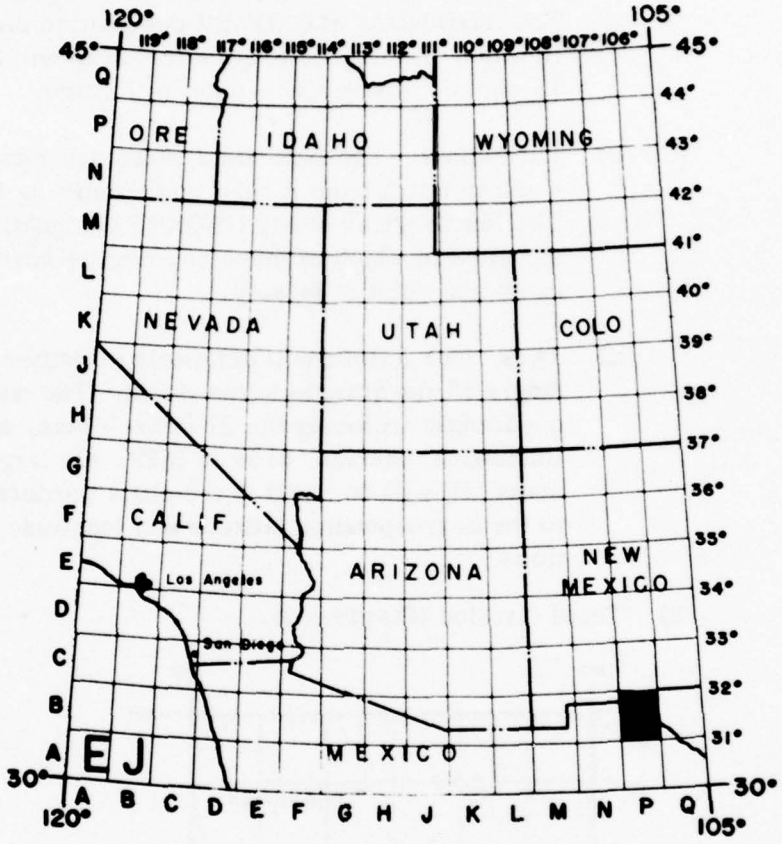


Diagram 2. GEOREF (second division).

a) One-degree quadrangles. Each basic 15-degree quadrangle is further divided into 225 one-degree quadrangles. This division is effected by dividing the basic 15-degree quadrangle into 15, one-degree, longitudinal zones from west to east and 15, one-degree, latitudinal bands from south to north.

b) Longitudinal. The longitudinal zones are lettered west to east from A through Q (omitting I and O). The third letter of GEOREF designation signifies in which one-degree longitudinal zone within the 15-degree quadrangle a point is located.

c) Latitudinal. The latitudinal bands are lettered south to north from A through Q (omitting I and O). The fourth letter of any GEOREF designation signifies in which of these one-degree latitudinal bands the point is located.

d) Thus, four letters will definitely identify any single 1°-quadrangle in the world. The one-degree quadrangle inclosing the El Paso, Texas, and Chihuahua, Mexico, area in EJPB. On large-scale maps, EJ will be found in the chart borders adjacent to the corresponding latitude and longitude numerations.

3) Third division (Diagram 3).

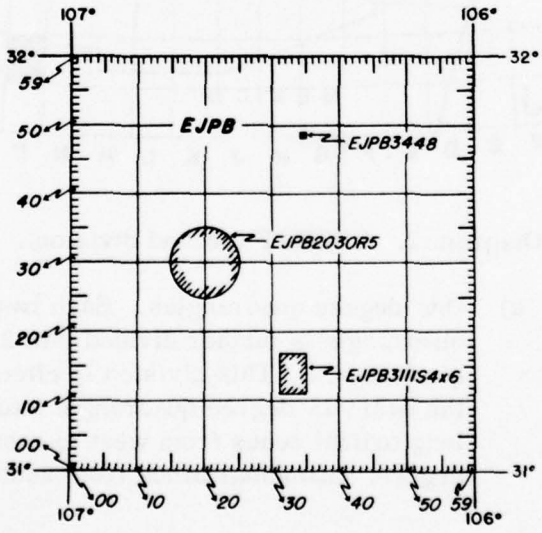


Diagram 3. GEOREF (third division).

a) One-minute quadrangles. Each one-degree quadrangle is divided into 3, 600 one-minute quadrangles. These one-minute quadrangles are formed by dividing the one-degree quadrangle into sixty one-minute longitudinal zones numbered, west to east, 0 through 59 and, south to north, 0 through 59.

b) To designate the location of one of these 3, 600 one-minute quadrangles, simply read right and up. Thus, the numerical part of the reference EJPB3448 designates the location of a certain one-minute quadrangle as being the 35th from the west and 49th from the south within the one-degree quadrangle, EJPB.

c) Therefore, four letters and four numerals will definitely identify any one-minute quadrangle anywhere in the world. This manner of numbering does not vary, even though the location may be west of the prime meridian or north or south of the equator. EJPB3448 encompasses a portion of the Fort Bliss area which is approximately one nautical mile square. (It should be remembered that one minute of latitude is approximately one nautical mile, and that one minute of longitude diminishes from approximately one nautical mile at the equator to zero at the poles.)

4) Decimal subdivision of one-minute quadrangles (Diagram 4)

If references of greater accuracy than one minute are required, each one-minute quadrangle may be further subdivided into decimal parts eastward and northward. Thus, four letters and six numerals will definitely identify any 1/10-minute quadrangle anywhere in the world (approximately 608 feet by 608 feet at the equator). EJPB342481 will designate an area 1/10 of a minute on each side in the El Paso area. By further increasing the denominator of the minute fraction, the area designated

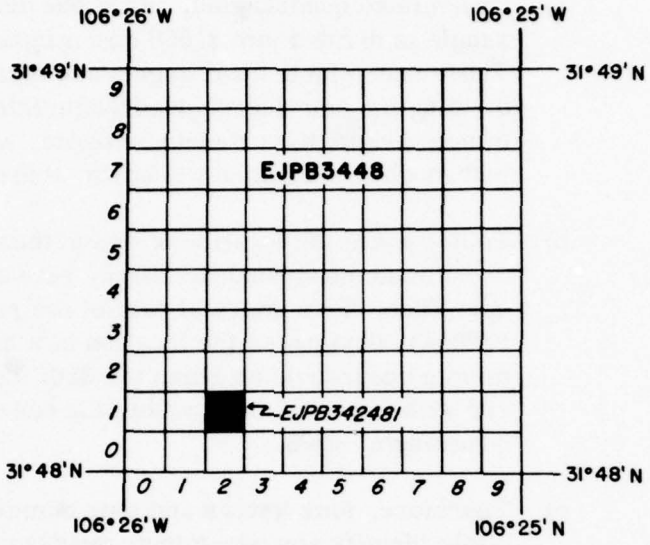


Diagram 4. GEOREF (decimal subdivision of one-minute quadrangles).

will be correspondingly reduced. EJPB34254815 would designate an area 1/100 of a minute on each side. While it is possible to designate this small an area, remembering the purposes of GEOREF for employment in military operations, the occasions calling for such fine breakdown will be rare. Normally the one-minute quadrangle will be the smallest breakdown required for air and air defense operations. For AADCP purposes at present, only the one-degree and one-minute designations, such as PB3448, are used.

INSTRUCTOR'S NOTE: Have the students follow the determination of a typical GEOREF designation carried to the third division. Then have the students solve selected problems requiring the designation of both the second and third divisions. As each problem is completed, explain and demonstrate its proper solution by utilizing visual-cast slides and the chalkboard.

c. Advantages of the World Geographic Reference System.

1) Appropriate code letters and figures can be printed on the map border, adjacent to the respective longitude and latitude designations, for ease and accuracy of use. Conversions between the code and the numerical latitudinal and longitudinal coordinates may be made by inspection alone without computation.

2) This code may be applied to all maps and charts without disfiguring them or interfering with their normal use; for example, use of universal transverse mercator grid system.

3) The GEOREF system is uniform and systematic in its composition. Each division is in harmony with every other division and with the spherical surface with which it is dealing. All subdivisions are contained completely in previous divisions, and there is no ambiguous overlapping. The code is simple and uniform because it designates the longitude and latitude reading of an area in a logical sequence, using letters and numerals. Each longitudinal reading is designated in a right direction only. The latitudinal reading is in an upward direction only.

4) The GEOREF system utilizes established military map reading habits of reading military grid coordinates right and up.

5) Other advantages.

a) The code is sufficiently brief for communication purposes. It may, for a local operation, be confined to a predesignated area (for example, a single map sheet) and be further shortened by dropping the 15-degree quadrangle designation letters. Further, for early warning purposes, fractional parts of a minute have been eliminated.

b) The character of the code is such that it cannot be confused with the conventional longitude and latitude readings. Those coordinates will continue to be printed on maps and charts for normal use.

SUMMARY:

1. The World Georgraphic Reference System is global in its scope. It is specifically designated as a reference system for the control and coordination of military forces operating over large areas of the earth's surface. The air defense early-warning systems will use the GEOREF system to locate targets.

2. The GEOREF system facilitates easy and rapid transmission of accurate positional data.

3. The system divides and subdivides the earth's surface into quadrangles formed by normal lines of longitude and latitude. There are three of these main divisions.

4. Positive and unique identification of each quadrangle so formed is given by a simple and brief code.

5. The breakdown of the identification code expressed by the four letters and six numerals EJPB342481 is as follows:

   a. EJ: 15-degree quadrangle (not presently used in AADCP),

   b. EJPB: 1-degree quadrangle,

   c. EJPB3448: 1-minute quadrangle, and

   d. EJPB342481: 1/10-minute quadrangle (not presently used in AADCP).

PRACTICAL EXERCISE

FIELD ADJUSTMENTS REVIEW

PRELIMINARY TROUBLE:

Misadjust all the operating controls associated with the day's exercise.

AAFCS M33 SETUP: Completely energized.

EQUIPMENT NECESSARY:

1. Two multimeters,
2. Synchroscope, and
3. Test amplifier.

PROCEDURE:

> INSTRUCTOR'S NOTE: The following six periods will be devoted to the adjustment of the acquisition and track radar systems. Split the class into two groups, and have them perform the adjustments according to the following schedule.

Note: This exercise covers Lesson Plans IM-1 through IM-6.

Day	Group I	Group II
1	a. Thyratron capsule voltage	a. Track range
	b. Magnetron filament	b. Computer
	c. Signal and AFC mixer	c. Track indicators

Day	Group I	Group II
	d. Mixer-crystal current	
	e. Receiver tuner (Review short cut using AFC.)	
2	a. STC	a. Track antenna positioning
	b. 4-kilocycle oscillator	1) Azimuth (MAN-AID-AUTO)
	c. PPI	2) Elevation (MAN-AID-AUTO)
	d. PI (Including mark generators and range computer.)	3) Range (MAN-AID-AUTO)
3	a. Moving target indicator	a. ATI b. AGC c. Lobing gain d. AFC e. TFI
4	a. Track range computer	a. Thyratron capsule voltage
	b. Track indicators	b. Magnetron filament c. Signal and AFC mixer d. Mixer-crystal current e. Receiver tuner (Review short cut using AFC.) f. Acquisition AFC
5	a. Track antenna positioning	a. STC
	1) Azimuth (MAN-AID-AUTO)	b. 4-kilocycle

Day	Group I	Group II
	2) Elevation (MAN-AID-AUTO)	c. PPI
	3) Range (MAN-AID-AUTO)	d. PI (Including mark generators and range computer.)
6	a. ATI	a. MTI
	b. AGC	
	c. Lobing gain	
	d. AFC	
	e. TFI	

IM-7

LESSON PLAN

SUPPLY AND ADMINISTRATIVE PROCEDURES

OBJECTIVE:

1. To explain the procedure for the procurement of parts.

2. To cover the purpose and procedure for filling out the following forms:

   a. Western Electric Returned Tube Information Sheet,

   b. DA 9-71, Locator and Inventory Control Card,

   c. DA 9-79, Parts Requisition,

   d. DD 200, Report of Survey,

   e. DA 446, Issue Slip,

   f. DA 447, Turn-in Slip,

   g. F342, Ordnance 7 Supply Catalog,

   h. DA 811, Work Request and Job Order,

   i. DA 460, Preventive Maintenance Roster,

   j. DA 11-246, Operator First Echelon Maintenance Check List For Signal Corps Equipment—Telephone Switchboard,

   k. DA 461, Preventive Maintenance Service and Inspection for Wheel and Half-Track Vehicles, and

   l. DA 464, Work Sheet For Preventive Maintenance and Technical Inspection of Engineer Equipment.

INTRODUCTION:

When the repairman reaches the field, he will be required to maintain certain forms. Records kept properly and completely will aid in the control of supply problems. Equipment records must be up to date for the Ordnance inspections. In this lesson the student will learn how and why these forms are maintained.

PRESENTATION:

1. Outline the supply channels and the items which are available from the following:

   a. Ordnance,

   b. Signal,

   c. Engineers, and

   d. Quartermaster.

2. Western Electric Returned Tube Information Sheet.

   a. Two copies of this form are provided with each new magnetron.

   b. Show the student how to fill out the form, and explain each part.

3. DA 9-71, Locator and Inventory Control Card.

   a. Most battery repairmen are required to keep a record of parts on hand.

   b. Form DA 9-71 provides a means of keeping the record of items as to the date received, balance on hand, and how many items are on order.

c. A description and the location of the item may also be recorded on the form.

INSTRUCTOR'S NOTE: As each form is covered, have the students fill in a sample copy. The use of the forms covered in this lesson will vary with some locations.

4. DA 9-79, Parts Requisition.

a. DA 9-79 is used in some locations as a memo from the battery repairman to the unit supply sergeant for the requisition of items listed on the form.

b. The form is used at times to requisition parts from Ordnance support teams.

5. DD 200, Report of Survey.

a. This form will be filled out by the battery commander.

b. Form DD 200 is also used for the quarterly droppage report.

6. DA 446, Issue Slip.

a. All items requisitioned by the battery are requested on form DA 446. Since this volume was originally prepared, DA Form 1546—a seven-part form for requesting a single-line item—is sometimes used.

b. The issue slip may be used for a hand receipt.

7. DA 447, Turn-In Slip.

a. All items in excess of the TO&E authorization will be recorded on form DA 447.

b. The Turn-In Slip is a receipt for the property, when it is signed and returned to the unit.

8. F342, Ordnance 7 Supply Catalog.

   a. Prefix F342 designates the item as part of the AAFCS M33 system.

   b. SNL is the abbreviation for "standard nomenclature listing."

   c. All items authorized to be requisitioned at the battery level are listed in the Ordnance 7 catalog.

INSTRUCTOR'S NOTE: Provide each student with a copy of this supply catalog for use during this lesson. Show its use, and have them look up several items. Show how the items are to be listed on an Issue Slip, DA 446.

9. DA 811, Work Request and Job Order.

   a. Certain equipment failures may require Ordnance support.

   b. When such support is necessary, the request will be submitted on DA 811.

   c. The following items will be completed by the battery:

      1) Date and organization,

      2) Technical service item,

      3) Description of the work to be performed, and

      4) Signature of a battery officer.

   d. Ordnance will complete the remainder of the form.

   e. The last page is retained by the battery as a receipt for equipment removed by the technical service.

10. DA 460, Preventive Maintenance Roster.

    a. Many troubles in the field may be prevented by equipment maintenance before the trouble occurs.

    b. The preventive maintenance roster provides the repairman with a record of items that need this service.

11. DA 11-246, Maintenance Check List For Signal Equipment: Telephone Switchboard-Field.

    a. This list shows which items need frequent cleaning and maintenance.

    b. This check list should be kept up to date and kept on file.

12. DA 461, Preventive Maintenance Service and Inspection For Wheel and Half-Track Vehicles.

    a. This record is kept to insure maintenance of the trailer undercarriage and acquisition antenna trailer.

    b. Normally, this record will be completed and filed by the battery motor sergeant.

13. DA 464, Work Sheet For Preventive Maintenance and Technical Inspection of Engineer Equipment.

    a. This work sheet will be completed and maintained for the generator.

    b. Usually the battery motor sergeant will keep this record.

IM-7

RETURNED TUBE INFORMATION SHEET

Western Electric Code 5780 Serial No. * _____

Location _____ Date Installed _____ Equip. No. * _____

DC Power Supply _____KV for _____MA. at _____ frequency
at time of installation.

Date Removed _____ Hours Life _____

DC Power Supply _____KV for _____MA. at _____ frequency
time of removal.

*Use number stamped on magnet under code marking. Do not use date coding number, such as 048, 113, etc.

Reason for Removal	Check
1. Unstable magnetron current meter reading at __ MA.avg. current	___
2. Unstable magnetron current meter reading at __MA.avg. current at following frequencies	___
3. Open heater	___
4. Shorted elements	___
5. Will not take required input	___
6. Will not tune intended band	___
7. Other reasons _____	

_____

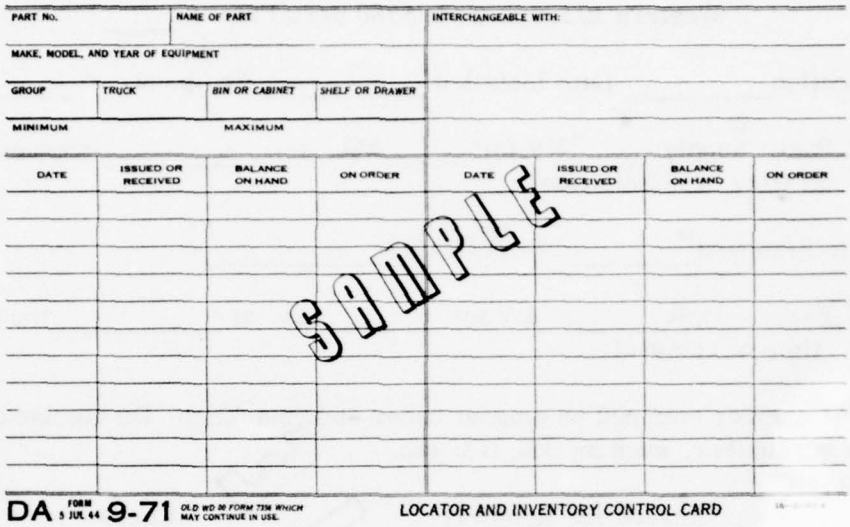
Were there any equipment difficulties or abnormalities associated with tube failure? If so, state:

_____

_____

Prepared by _____

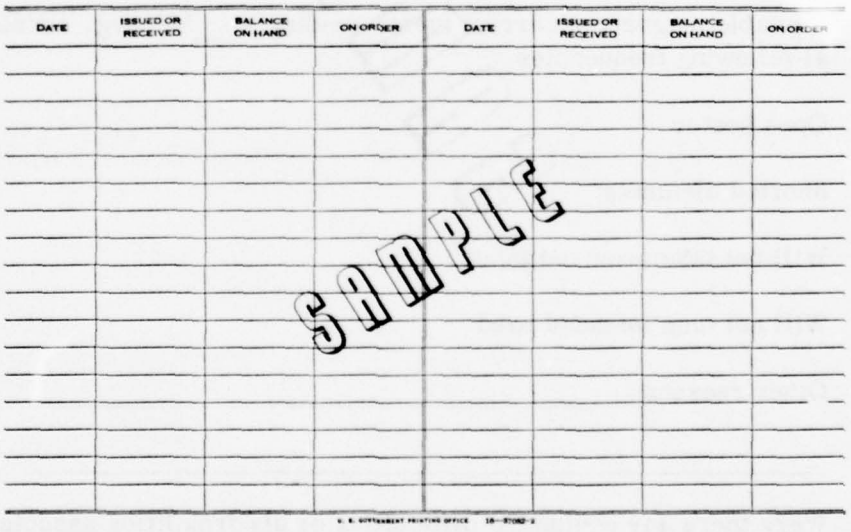
Plate 5. Returned tube information sheet.



PART No.	NAME OF PART			INTERCHANGEABLE WITH:			
MAKE, MODEL, AND YEAR OF EQUIPMENT							
GROUP	TRUCK	BIN OR CABINET	SHELF OR DRAWER				
MINIMUM		MAXIMUM					
DATE	ISSUED OR RECEIVED	BALANCE ON HAND	ON ORDER	DATE	ISSUED OR RECEIVED	BALANCE ON HAND	ON ORDER

DA FORM 5 JUL 44 9-71 OLD WD 20 FORM 7396 WHICH MAY CONTINUE IN USE. LOCATOR AND INVENTORY CONTROL CARD

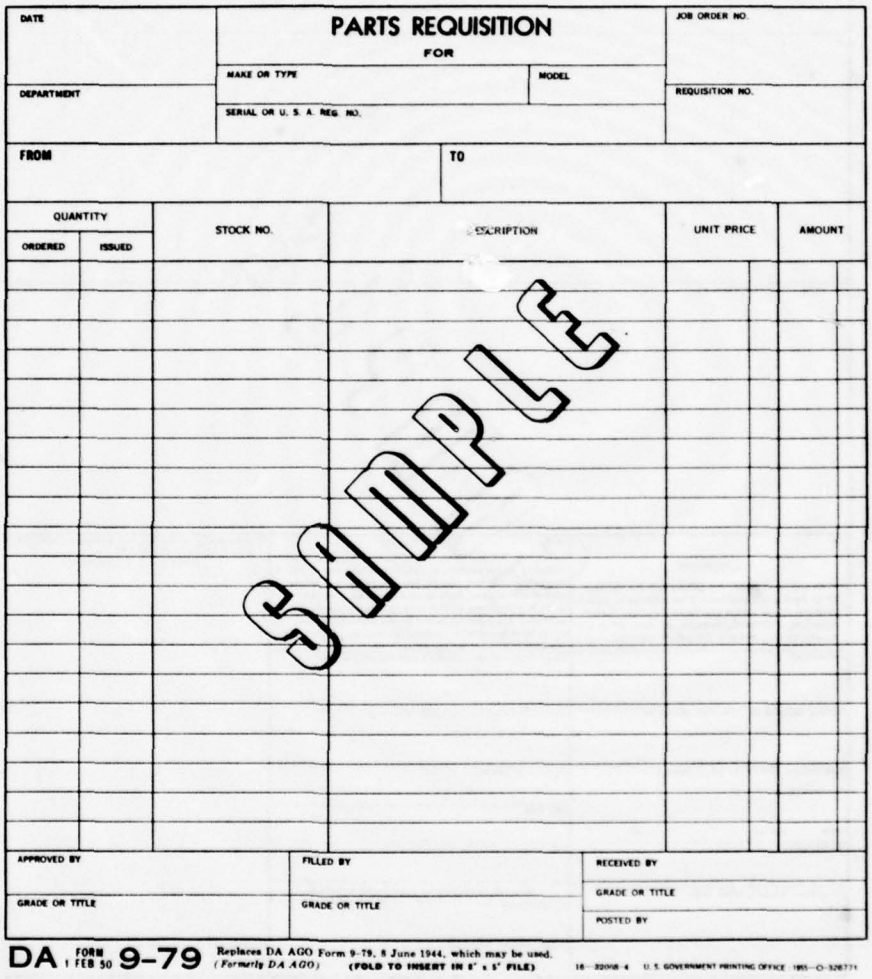
(1) Front (DA Form 9-71).



DATE	ISSUED OR RECEIVED	BALANCE ON HAND	ON ORDER	DATE	ISSUED OR RECEIVED	BALANCE ON HAND	ON ORDER

(2) Back (DA Form 9-71).

Plate 6. Locator and Inventory Control Card (DA Form 9-71).



DATE

PARTS REQUISITION

FOR

JOB ORDER NO.

DEPARTMENT

MAKE OR TYPE

MODEL

REQUISITION NO.

SERIAL OR U. S. A. REG. NO.

FROM

TO

QUANTITY ORDERED	QUANTITY ISSUED	STOCK NO.	DESCRIPTION	UNIT PRICE	AMOUNT

SAMPLE

APPROVED BY

GRADE OR TITLE

FILLED BY

GRADE OR TITLE

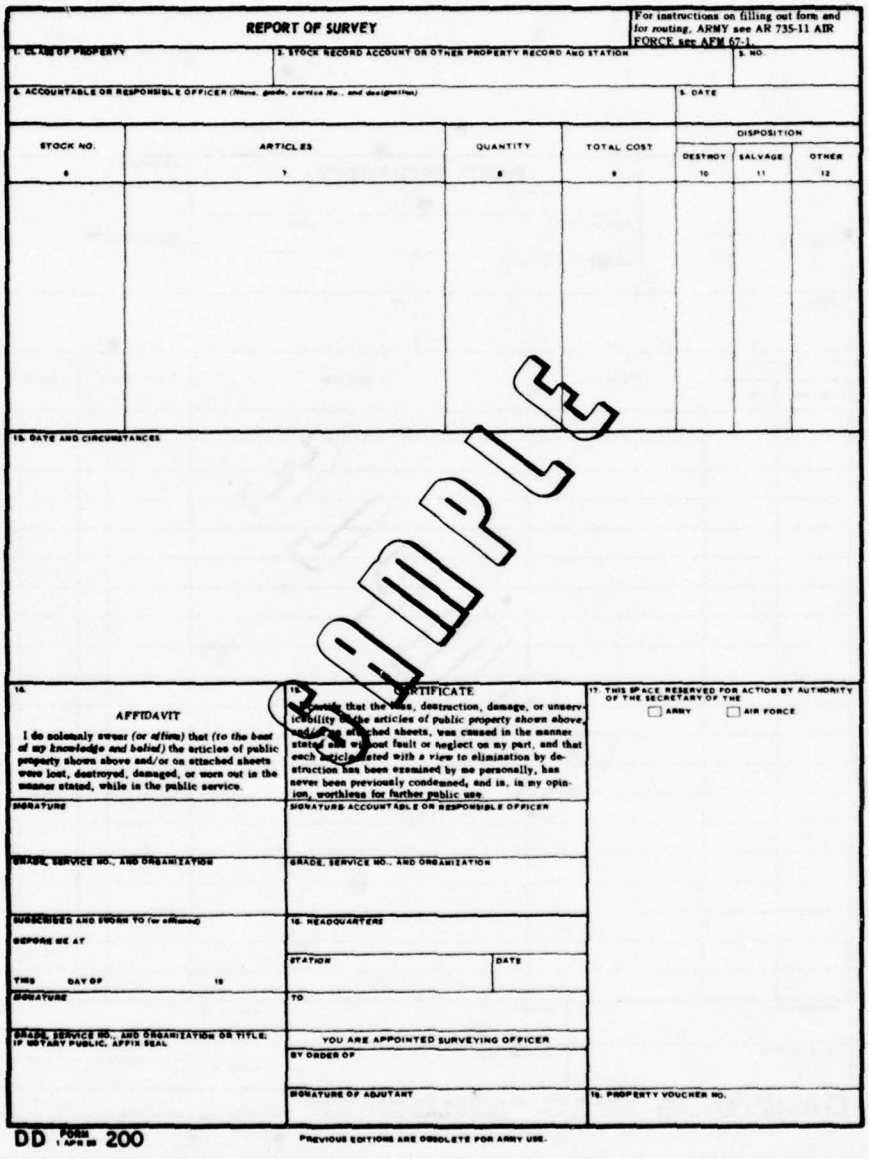
RECEIVED BY

GRADE OR TITLE

POSTED BY

DA FORM 1 FEB 50 9-79 Replaces DA AGO Form 9-79, 8 June 1944, which may be used. *(Formerly DA AGO)* (FOLD TO INSERT IN 8" x 5" FILE) 16—32018-4 U. S. GOVERNMENT PRINTING OFFICE 1955—O-326771

Plate 7. Parts Requisition (DA Form 9-79).



REPORT OF SURVEY

For instructions on filling out form and for routing, ARMY see AR 735-11 AIR FORCE see AFM 67-1.

1. GL ACC OF PROPERTY | 2. STOCK RECORD ACCOUNT OR OTHER PROPERTY RECORD AND STATION | 3. NO.

4. ACCOUNTABLE OR RESPONSIBLE OFFICER (Name, grade, service No., and designation) | 5. DATE

STOCK NO. 6	ARTICLES 7	QUANTITY 8	TOTAL COST 9	DISPOSITION		
				DESTROY 10	SALVAGE 11	OTHER 12

13. DATE AND CIRCUMSTANCES

SAMPLE

14. AFFIDAVIT

I do solemnly swear (or affirm) that (to the best of my knowledge and belief) the articles of public property shown above and/or on attached sheets were lost, destroyed, damaged, or worn out in the manner stated, while in the public service.

SIGNATURE

GRADE, SERVICE NO., AND ORGANIZATION

SUBSCRIBED AND SWORN TO (or affirmed) BEFORE ME AT

THIS DAY OF 19

SIGNATURE

GRADE, SERVICE NO., AND ORGANIZATION OR TITLE. IF NOTARY PUBLIC, AFFIX SEAL

15. CERTIFICATE

I certify that the loss, destruction, damage, or unserviceability of the articles of public property shown above, and/or on attached sheets, was caused in the manner stated and without fault or neglect on my part, and that each article listed with a view to elimination by destruction has been examined by me personally, has never been previously condemned, and is, in my opinion, worthless for further public use.

SIGNATURE ACCOUNTABLE OR RESPONSIBLE OFFICER

GRADE, SERVICE NO., AND ORGANIZATION

16. HEADQUARTERS

STATION | DATE

TO

YOU ARE APPOINTED SURVEYING OFFICER

BY ORDER OF

SIGNATURE OF ADJUTANT

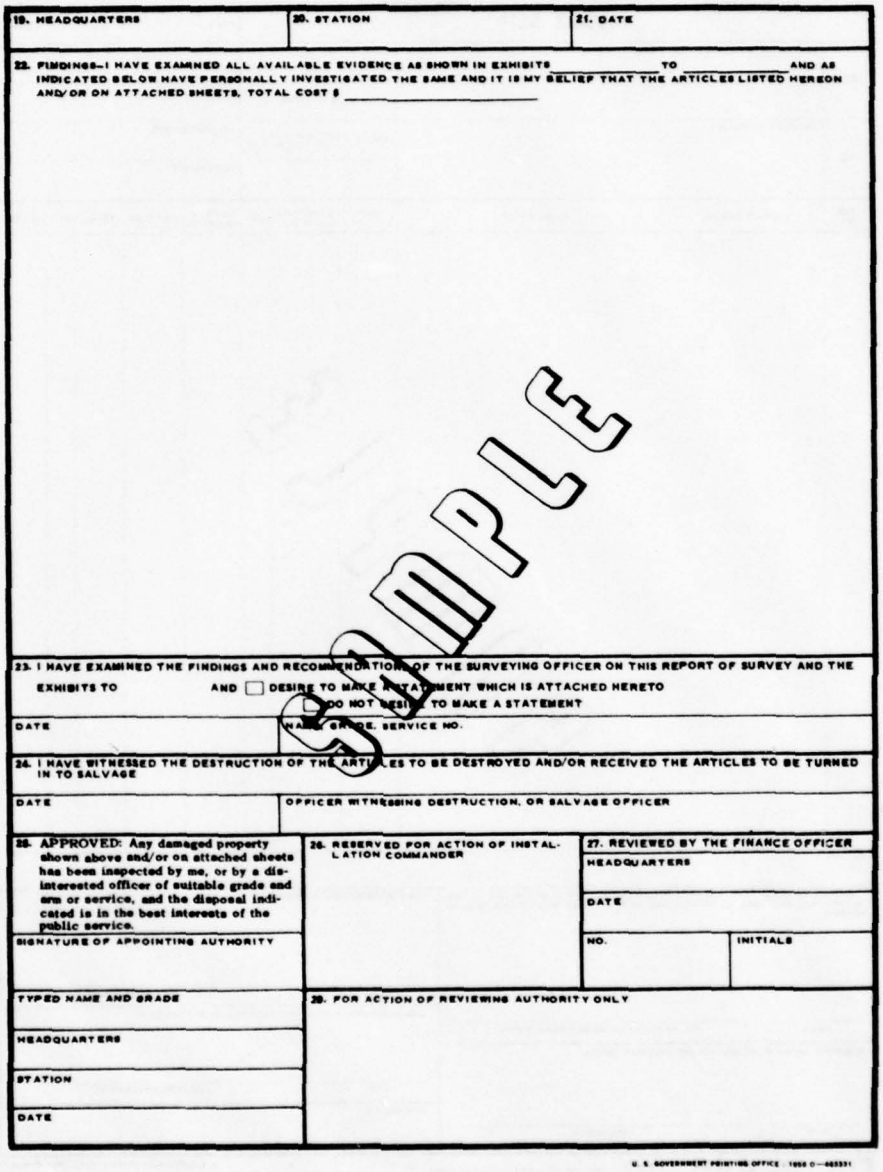
17. THIS SPACE RESERVED FOR ACTION BY AUTHORITY OF THE SECRETARY OF THE ☐ ARMY ☐ AIR FORCE

18. PROPERTY VOUCHER NO.

DD Form 1 APR 48 200

PREVIOUS EDITIONS ARE OBSOLETE FOR ARMY USE.

Plate 8. Report of Survey (DD Form 200), front.



19. HEADQUARTERS	20. STATION	21. DATE

22. FINDINGS--I HAVE EXAMINED ALL AVAILABLE EVIDENCE AS SHOWN IN EXHIBITS _____ TO _____ AND AS INDICATED BELOW HAVE PERSONALLY INVESTIGATED THE SAME AND IT IS MY BELIEF THAT THE ARTICLES LISTED HEREON AND/OR ON ATTACHED SHEETS, TOTAL COST $ _____

23. I HAVE EXAMINED THE FINDINGS AND RECOMMENDATIONS OF THE SURVEYING OFFICER ON THIS REPORT OF SURVEY AND THE EXHIBITS TO _____ AND ☐ DESIRE TO MAKE A STATEMENT WHICH IS ATTACHED HERETO
☐ DO NOT DESIRE TO MAKE A STATEMENT

DATE	NAME, GRADE, SERVICE NO.

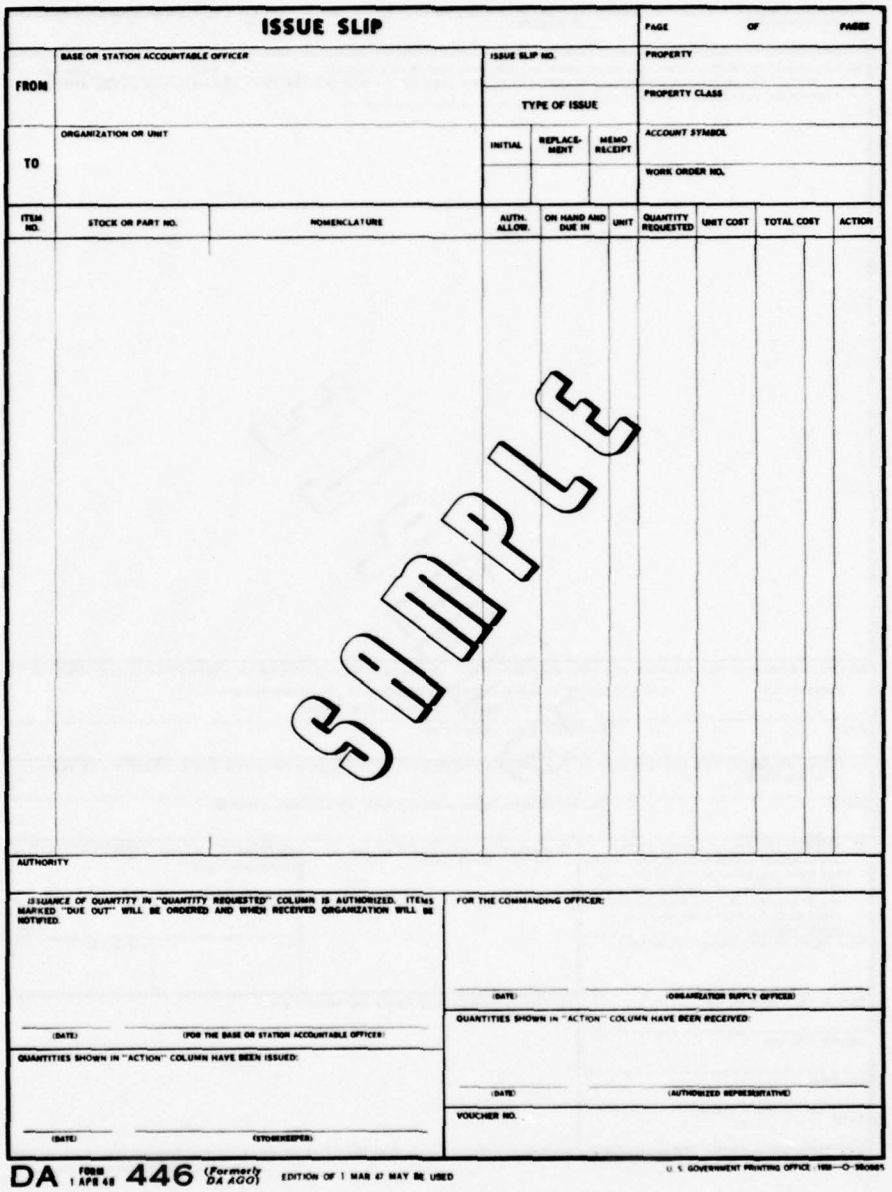
24. I HAVE WITNESSED THE DESTRUCTION OF THE ARTICLES TO BE DESTROYED AND/OR RECEIVED THE ARTICLES TO BE TURNED IN TO SALVAGE

DATE	OFFICER WITNESSING DESTRUCTION, OR SALVAGE OFFICER

25. APPROVED: Any damaged property shown above and/or on attached sheets has been inspected by me, or by a disinterested officer of suitable grade and arm or service, and the disposal indicated is in the best interests of the public service.	26. RESERVED FOR ACTION OF INSTALLATION COMMANDER	27. REVIEWED BY THE FINANCE OFFICER HEADQUARTERS DATE NO. / INITIALS
SIGNATURE OF APPOINTING AUTHORITY		
TYPED NAME AND GRADE	28. FOR ACTION OF REVIEWING AUTHORITY ONLY	
HEADQUARTERS		
STATION		
DATE		

U. S. GOVERNMENT PRINTING OFFICE : 1956 O—465331

Plate 9. Report of Survey (DD Form 200), back.



ISSUE SLIP

PAGE ___ OF ___ PAGES

FROM: BASE OR STATION ACCOUNTABLE OFFICER

ISSUE SLIP NO.

PROPERTY

TYPE OF ISSUE: INITIAL | REPLACEMENT | MEMO RECEIPT

PROPERTY CLASS

TO: ORGANIZATION OR UNIT

ACCOUNT SYMBOL

WORK ORDER NO.

ITEM NO.	STOCK OR PART NO.	NOMENCLATURE	AUTH. ALLOW.	ON HAND AND DUE IN	UNIT	QUANTITY REQUESTED	UNIT COST	TOTAL COST	ACTION

SAMPLE

AUTHORITY

ISSUANCE OF QUANTITY IN "QUANTITY REQUESTED" COLUMN IS AUTHORIZED. ITEMS MARKED "DUE OUT" WILL BE ORDERED AND WHEN RECEIVED ORGANIZATION WILL BE NOTIFIED.

(DATE) (FOR THE BASE OR STATION ACCOUNTABLE OFFICER)

FOR THE COMMANDING OFFICER:

(DATE) (ORGANIZATION SUPPLY OFFICER)

QUANTITIES SHOWN IN "ACTION" COLUMN HAVE BEEN ISSUED:

(DATE) (STOREKEEPER)

QUANTITIES SHOWN IN "ACTION" COLUMN HAVE BEEN RECEIVED:

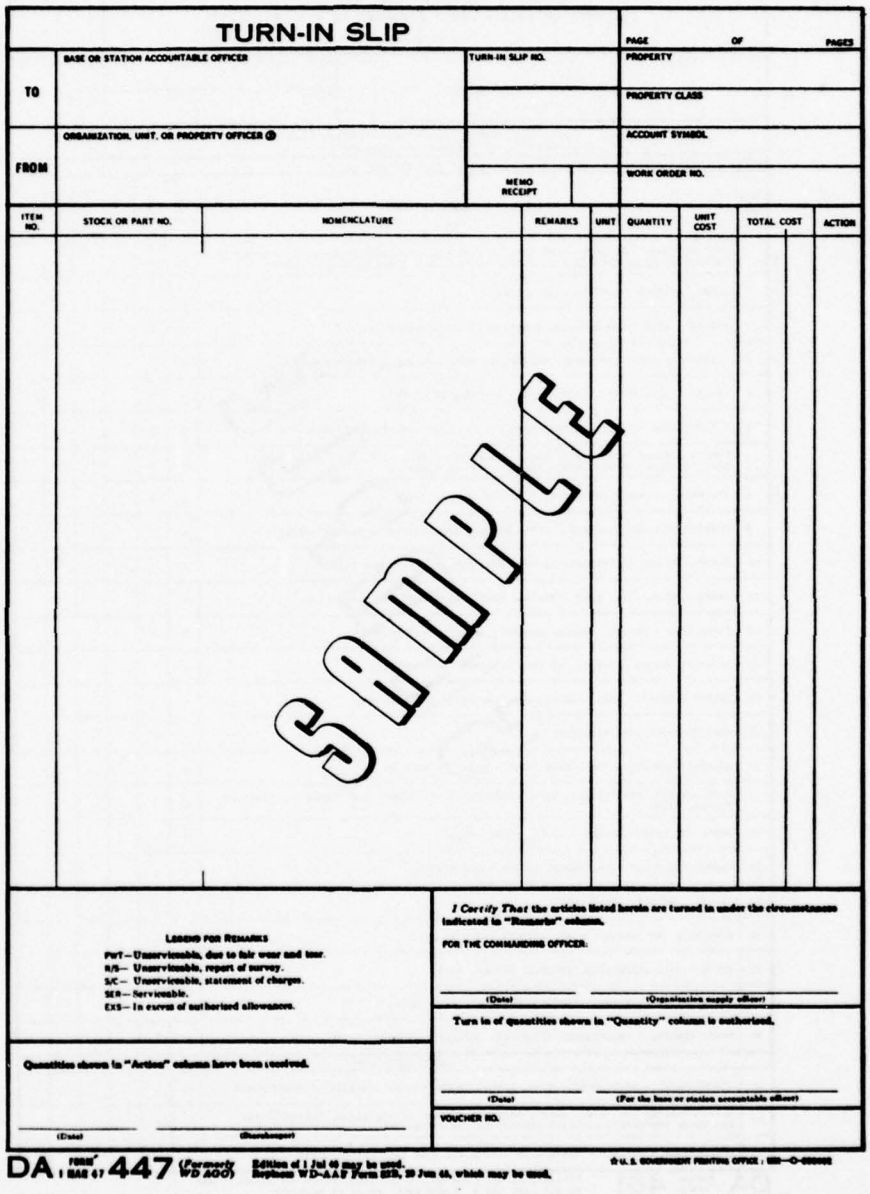
(DATE) (AUTHORIZED REPRESENTATIVE)

VOUCHER NO.

DA FORM 1 APR 48 446 (Formerly DA AGO) EDITION OF 1 MAR 47 MAY BE USED

U. S. GOVERNMENT PRINTING OFFICE 1951—O-930861

Plate 10. Issue Slip (DA Form 446).



TURN-IN SLIP

PAGE OF PAGES

TO: BASE OR STATION ACCOUNTABLE OFFICER

TURN-IN SLIP NO.

PROPERTY

PROPERTY CLASS

FROM: ORGANIZATION, UNIT, OR PROPERTY OFFICER

ACCOUNT SYMBOL

MEMO RECEIPT

WORK ORDER NO.

ITEM NO.	STOCK OR PART NO.	NOMENCLATURE	REMARKS	UNIT	QUANTITY	UNIT COST	TOTAL COST	ACTION

SAMPLE

LEGEND FOR REMARKS

Fwt— Unserviceable, due to fair wear and tear.
R/S— Unserviceable, report of survey.
S/C— Unserviceable, statement of charges.
SER— Serviceable.
EXS— In excess of authorized allowances.

I Certify That the articles listed herein are turned in under the circumstances indicated in "Remarks" column.

FOR THE COMMANDING OFFICER:

(Date) (Organization supply officer)

Quantities shown in "Action" column have been received.

(Date) (Receiptor)

Turn in of quantities shown in "Quantity" column is authorized.

(Date) (For the base or station accountable officer)

VOUCHER NO.

DA FORM 1 MAR 47 447 (Formerly WD AGO) Editions of 1 Jul 46 may be used. Replaces WD-AAF Form 615, 20 Jun 45, which may be used.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1950—O-892002

Plate 11. Turn-in Slip (DA Form 447).

PREVENTIVE MAINTENANCE SERVICE AND INSPECTION FOR WHEEL AND HALF-TRACK VEHICLES

(60 DAYS OR 1000 MILES - 6 MONTHS OR 6000 MILES)

(TM 9-2810)

DATE

VEHICLE REGISTRATION NO.	ORGANIZATION OR ACTIVITY	POST, CAMP OR STATION	LOCATION

MAKE	MODEL	SIZE	DRIVE	TYPE	MILEAGE

BEFORE OPERATION: Fuel, Oil, Water, Anti-Freeze, Tires, Instruments, Leaks, General Visual Inspection of Vehicle and Equipment

NOTE: Circle applicable word(s) to identify deficiency.

ITEM NO.	INSPECTION AND ROAD TEST	1000	6000	O.K.	ADJUST	REPAIR	MECH. INITIALS
1	DASH INSTRUMENTS, SWITCHES & GUAGES, OIL PRESSURE, VISCOMETER, AMMETER, VOLTMETER, SPEEDOMETER, TACHOMETER, TEMPERATURE, FUEL, AIR PRESSURE, IGNITION SWITCH, AND ALL OTHER CONTROLS	X	X				
2	HORNS, MIRRORS AND WINDSHIELD WIPERS	X	X				
3	ENGINE - IDLE, ACCELERATION, POWER, NOISE, GOVERNED SPEED	X	X				
4	STEERING - FREE PLAY, BIND, WANDER, SHIMMY, SIDE PULL, COLUMN AND WHEEL	X	X				
5	CLUTCH - FREE TRAVEL, DRAG, NOISE, CHATTER, GRAB, SLIP	X	X				
6	AIR PRESSURE - BUILD UP, GOVERNOR, CUT OFF, AND LOW PRESSURE INDICATOR	X	X				
7	BRAKES - *(Foot, hand and trailer)* - BRAKING EFFECT, FEEL, SIDE PULL, NOISE, CHATTER, PEDAL TRAVEL, HAND CONTROL - AIR OR ELECTRIC	X	X				
8	GENERATOR, STARTER AND SWITCH - ACTION, NOISE, SPEED	X	X				
9	TRANSMISSION AND TRANSFER - LEVER ACTION, DECLUTCHING, VIBRATION NOISE	X	X				
10	UNUSUAL NOISES - ATTACHMENTS, CAB, BODY AND WHEELS, TRAILER	X	X				
11	LAMPS - HEAD, TAIL, BODY, RUNNING, DIRECTIONAL STOP AND BLACKOUT	X	X				
12	BILGE PUMP - DRIVES, VALVES, CONTROLS, CABLES, AND STRAINERS	X	X				
13	WATER PROPELLOR - SHAFTS, JOINTS, BEARINGS, STUFFING BOX	X	X				
14	RUDDER - SHAFTS, ARMS, CABLES, BRACKETS, STUFFING BOX	X	X				
15	HAND CRANK RATCHET AND COVER	X	X				
16	ANCHOR, HAND BILGE PUMP, BOAT HOOKS AND SAFETY DEVICES	X	X				
17	HULL - PLUGS, RUB STRAKES, DECKS, HATCHES, VENTILATORS, COMPARTMENTS, BULKHEADS, PLATES, *FRAME*	X	X				
18	PROPELLOR SHAFT HOUSING - SEALS, BOOTS, PLUGS	X	X				
19	RUDDER AND SHEAR-PINS, PROPELLOR STRUT AND BEARING	X	X				
20	TRACKS - GUIDES, TREAD WEAR	X	X				
21	SPROCKETS AND IDLERS - RIMS, FLANGES, BEARING SEALS	X	X				
22	BOGIE - CRAB ASSEMBLIES, SPRINGS, GUIDES, BOLTS	X	X				
23	BOGIE ROLLERS - TIRES, FLANGES, BEARINGS, SEALS, BOLTS	X	X				
24	TRACK TENSION - ADJUSTMENT, IDLER POST SHACKLES, BRACKETS	X	X				
	AFTER ROAD TEST						
25	TEMPERATURES - BRAKE DRUMS, HUBS, AXLES, TRANSMISSION, TRANSFER, DIFFERENTIALS	X	X				
26	LEAKS - ENGINE OIL, FUEL, WATER, AXLES, HOUSINGS, TRANSMISSION, TRANSFER AND ALL OTHER COMPONENTS CARRYING FLUIDS, OIL OR GREASE	X	X				
27	LUBRICATION - LUBRICATE VEHICLE IN ACCORDANCE WITH LUBRICATION ORDER	X	X				

DA FORM 1 JUN 51 **461** REPLACES WD AGO FORM 461, 1 JUL 1945, WHICH MAY BE USED, AND WD AGO FORM 461-3, 1 APR 1945, WHICH IS OBSOLETE.

Plate 12. Preventive Maintenance Service and Inspection For Wheel and Half-Track Vehicles (DA Form 461), front.

ITEM NO.	MAINTENANCE OPERATION	1000	6000	O.K.	ADJUST	REPAIR	MECH INITIALS
28	BATTERY - SPECIFIC - GRAVITY 1 2 3 4 5 6 7 8 9 10 11 12	x	x				
29	BATTERY - VOLTAGE 1 2 3 4 5 6 7 8 9 10 11 12	x	x				
30	COMPRESSION 1 2 3 4 5 6 7 8 9 10 11 12	x	x				
31	BREATHER CAPS AND VENTILATORS		x				
32	RADIATOR - CORE, SHELL, SHUTTERS, HOSE, CAP, AND GASKET, OVERFLOW TANK, STEAM RELIEF TUBE AND VALVE		x				
33	WATER PUMP, FAN, DRIVE BELTS, AND PULLEYS		x				
34	VALVE MECHANISM - CLEARANCE, COVER GASKETS		x				
35	SPARK PLUGS - CLEAN AND ADJUST, DISTRIBUTOR, CAP, ROTOR, POINTS, [illegible] ADVANCE UNITS, COIL AND WIRING, IGNITION TIMING		x				
36	MANIFOLD AND HEAT CONTROL		x				
37	CARBURETOR, CHOKE, THROTTLE, LINKAGE, FUEL FILTERS, SCREEN AND LINES		x				
38	EXHAUST PIPE AND MUFFLER		x				
39	BRAKE SHOES - LININGS, LINKS, GUIDES, ANCHORS, SUPPORTS, CYLINDERS, CAMS, HOSE AND AIR CHAMBERS		x				
40	CAB AND PASSENGER BODY - DOORS, HARDWARE, GLASS, TOP AND FRAME, CURTAINS AND FASTENERS, SEATS, UPHOLSTERY, TRIM, SAFETY STRAPS AND PAINT		x				
41	FIFTH WHEELS - BED PLATE, AND HOLD DOWN BOLTS		x				
42	BUMPERS - FRONT AND REAR, PINTLE HOOKS		x				
43	TOW HITCH - KING PIN, FIFTH WHEEL PLATE, LUNETTE		x				
44	WINCHES - POWER TAKE-OFF - TECHNICAL INSPECTION [illegible] MONTHS OR 6000 MILES		x				

REMARKS

SAMPLE

U.S. GOVERNMENT PRINTING OFFICE : 1951 O - 930974

Plate 13. Preventive Maintenance Service and Inspection for Wheel and Half-Track Vehicles (DA Form 461), back.

WORK REQUEST AND JOB ORDER

....., 19.....

Organization .....

TECHNICAL SERVICE ITEM	ORD	QMC	SIG	ENG	TRANS	CWS	MED

Reference No. .....

DESCRIPTION OF WORK TO BE PERFORMED

Authorized by ..... Received by .....

FILL IN ABOVE AS WORK REQUEST

ROUTING AND FLOW

ASSIGNED TO—	DATE IN	SIGN	DATE OUT	SIGN	FINAL INSPECTION
☐ A—Automotive					
☐ I—Armament and Inst					
☐ C—Clothing and Equip					
☐ E—Electric					
☐ M—Machine					
☐ P—Paint					
☐					
☐					
☐					
☐ To higher echelon for repair or reclamation					

COMPLETION DATA	DATE RECEIVED	ORGANIZATION OR WAREHOUSE	RECEIVED BY—
☐ Salvage			
☐ Organization			
☐ Warehouse			
☐			

SHIPPING INSTRUCTION FOR EVACUATING EQUIPMENT

Shipped to .....

Address .....

DA FORM 9 FEB 44 811 (Formerly WD AGO)

U. S. GOVERNMENT PRINTING OFFICE 16—88707-3

Account Code No. ..... | Priority | Job Order No. .....

INSTRUCTIONS FOR WORK TO BE PERFORMED

QUANTITY	NUMBER	WORK TO BE PERFORMED OR NOMENCLATURE

Per ..... *Inspector.*

CONTROL OFFICE DATA

Date received ..... Total time (man-hours) .....

Estimated hours ..... File date .....

(USE BACK FOR ADDITIONAL DATA IF NECESSARY)

Plate 14. Work Request and Job Order (DA Form 811).

SYMBOLS
C - CLEAN
T - TIGHTEN
A - ADJUST
L - SPECIAL LUBRICATION
S - SERVICE
TI - TECHNICAL INSPECTION
M - MONTHLY
W - WEEKLY

WORK SHEET FOR PREVENTIVE MAINTENANCE AND TECHNICAL INSPECTION OF ENGINEER EQUIPMENT
(SEE INSTRUCTIONS ON PAGE 6 BEFORE MAKING ENTRIES) (AR 750-8 and TM 5-505)

LEGEND FOR MARKING
NA - NOT APPLICABLE
M - MISSING
✓ - SATISFACTORY
X - ADJUSTMENT REQUIRED
XX - REPAIRS REQUIRED
XXX - REPLACEMENT REQUIRED
D - IMMEDIATE DEADLINE
O - DEFECT CORRECTED
U - PREVIOUSLY REPORTED DEFECT UNCORRECTED

NOMENCLATURE			MAKE		MODEL	
ORGANIZATION		DATE	HOURS	MILES	SERIAL NO.	
ENGINE MAKE AND MODEL	ENGINE NO.	ATTACHMENT				WEEKLY 1 2 3
ENGINE MAKE AND MODEL	ENGINE NO.	MAKE AND MODEL				MONTHLY MONTH
		SERIAL NUMBER				USA OR POOL NO.

PRIMARY UNIT TI M	PRIMARY UNIT TI W	GENERAL			SECONDARY UNIT TI M	SECONDARY UNIT TI W	PRIMARY ENGINE TI M	PRIMARY ENGINE TI W	ENGINES OR POWER UNITS		STARTING OR OTHER ENGINES TI M	STARTING OR OTHER ENGINES TI W
S	S	1. BEFORE OPERATION SVCS		1A	S	S			11 CYLINDER HEAD, MANIFOLD, MUFFLER, EXHAUST PIPE - Gaskets, leaks	11A		
L	L	2. LUBRICATION		2A	L	L	A		12 VALVE MECHANISM - Covers, springs, rocker arms, push rods SPECIFIED CLEARANCE	12A	A	
		DALO	DATE						13 COMPRESSION TEST - For T. I. or malfunction purposes only	13A		
		DALO	DATE						1 2 3 4 5 6 7 8			
C	C	3. TOOLS AND EQUIPMENT		3A	C	C			8 7 6 5 4 3 2 1			
		4. FIRE EXTINGUISHER - See AR 385-55		4A					14 CRANKCASE, BREATHERS - Leaks, oil level	14A		
		5. PUBLICATIONS		5A					15 OIL FILTERS, OIL COOLERS - Lines, leaks	15A		
		TM	TB'S				S	S	16 RADIATOR - Core, shutters, mounting hoses, connections, cap and gasket Antifreeze protection to ______ °F	16A	S	S
		ENG 7, 8, 9	SB'S						17 WATER PUMP, FAN, SHROUD - Leaks, alignment, mounting	17A		
		TM	TB'S				A	A	18 BELTS AND PULLEYS	18A	A	A
		ENG 7, 8, 9	SB'S						19 OIL PUMP PRESSURE RELIEF VALVE Oil pressure ______ Oil pressure ______	19A		
		6. APPEARANCE - Cleanliness, paint, Identification Plates		6A					20 GOVERNOR AND LIN[illegible] - Seal	20A		
		7. MODIFICATIONS		7A					21 OVERSPEED GOVERNORS	21A		
		MWO	DATE						22 PRIMER, AIR BOX DRAINS - Lines, connections	22A		
									33 CLUTCH AND TRANSMISSION - Starting engine only	33A		
									38 FUEL PUMPS AND HOUSING - Lines, connections and sediment bowl	38A		
									39 CARBURETOR AND LINKAGE	39A		
		8. OPERATOR'S REPORT OF MOTOR-VEHICLE ACCIDENT - Standard Form 91		8A					40 FUEL FILTER	40A		
		9.		9A			CS	CS	41 AIR CLEANERS AND PRECLEANERS - Leaks, connections and mounting	41A	CS	CS
		10.		10A					42 NOZZLES, INJECTOR PUMPS - Housings	42A		

PRIMARY ENGINE TI M	PRIMARY ENGINE TI W	ENGINES OR POWER UNITS *(Continued)*									STARTING OR OTHER ENGINES TI M	STARTING OR OTHER ENGINES TI W
		43 TANK, CAP AND GASKETS - Valves, lines, traps, screens and mounting 43A										
		44 FUEL LINES 44A										
		45 AIRBOX, BLOWER, TRANSFER PUMP 45A										
		46 SPARK PLUGS - Clean and check gap as necessary 46A										
		GAP				GAP						
CS	CS	47 BATTERY - Holder, cables, connections, water *(Record specific gravity)* 47A									CS	CS
1	2	3	4	5	6	7	8	9	10		11	12
12	11	10	9	8	7	6	5	4	3		2	1
		48 GENERATORS, STARTER - Mounting and connections 48A										
		49 DISTRIBUTOR OR MAGNETO - Cap, rotor, points, mounting GAP ______ 49A										
		50 COIL, WIRING, SWITCHES 50A										
		51 VOLTAGE REGULATOR - Seal 51A										
		52 LIGHTS - Connections and mountings 52A										
		53 AIR HEATER 53A										
		57 GAGES - Fuel, oil, temperature, pressure, vacuum 57A										
		58 METERS - Voltmeter, ammeter, hourmeter, odometer, tachometer, speedometer 58A										
		62 LEVERS, PEDALS, LINKAGE, CABLES 62A										
		80 FRAME - Cracks, welds, alinement *(Power unit only)* 80A										
		84 HOOD, PANELS, DOORS - *(Power unit only)* 84A										
		95 MASTER CLUTCH - *(Power unit only)* Housings, bearings 95A										

SAMPLE

DA FORM 464 1 JUL 57 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

Page 1

Plate 15. Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment (DA Form 464), page 1.

SERIAL NUMBER

PUMPS		GENERATORS AND WELDERS		COMPRESSORS	
38 REGULATOR, CHECK VALVE, SAFETY VALVE		82 LIGHTS, WIRING, SWITCHES - Mountings and connections	CS	61 AIR CLEANERS, PRECLEANERS - Leaks, connections and mountings	CS
61 VALVES, CYLINDERS, JACKS - Seals, gaskets, packing, leaks, lines		89 REGULATOR, RHEOSTAT		68 REGULATOR, CHECK VALVE, SAFETY VALVE, GAGES	
80 FRAME - Cracks, welds, alignment		71 VERNIER THROTTLE CONTROL - Mounting	S S	76 TIRES - *(Record pressure on page 6)*	
106 DRIVE SHAFTS, U JOINTS, PISTONS, GEARS AND GEAR CASES		84 BASE, SKIDS, HOODS AND SIDE PANELS - Hinges and fasteners		81 FRONT AXLE ASSEMBLY, WHEELS - Bearings, mountings	
110 COUPLINGS		172 ARMATURE, COMMUTATOR AND SLIP RINGS - Brushes, holders, bearings		82 REAR AXLE ASSEMBLY, WHEELS - Bearings, mountings	
183 IMPELLER, DIAPHRAGM		173 CONTROLS, INSTRUMENTS - Mountings, linkage, connections		85 SPRINGS, EQUALIZERS, STABILIZERS - Brackets, shackles, mountings	
184 SHAFTS AND BEARINGS - Alignment, gaskets, seals		174 DRIVE COUPLING, VENTILATING FAN		88 BASE, SKIDS, HOODS, SIDE PANELS - Hinges, fasteners	
188 PUMP HOUSING, DRAIN PLUGS - Cracks, welds		176 CONTROL PANEL - METERS - Ammeter, voltmeter, frequency meter, wattmeter, wiring	A A	94 DRIVES, SPROCKETS, CHAINS, BELTS	
196 HOSE AND STRAINER		216 ELECTRIC MOTORS - Wiring, connections, mounting		104 GEARS AND PINIONS	
				110 DRIVE COUPLING	
ROLLERS		TRAILERS AND DOLLIES		133 RADIATOR (compressor) - Core, shutters, mountings, hoses, Antifreeze protection to ___°F	
52 LIGHTS, WIRING, SWITCHES - Mountings and connections		52 LIGHTS, WIRING, SWITCHES - Mountings, connections		134 WATER PUMP, FAN, SHROUDS (compressor) - Leaks, alignment, mountings	
58 STEERING GEAR ASSEMBLY - Steering yoke		61 VALVES, CYLINDERS, JACKS - Seals, packing, leaks, lines, gaskets		135 BELTS AND PULLEYS (compressor)	A A
60 HYDRAULIC PUMP - Hoses, connections, mounting		71 RELAY, EMERGENCY VALVE - Lines, connections	A A	137 AIR RECEIVER TANK	
61 VALVES AND CYLINDERS - Gaskets, seals, packing, leaks and lines		72 HOSE, COUPLING, CONNECTIONS		138 AIR BREATHERS, AIR HOSES AND CONNECTIONS	
62 LEVERS, PEDALS AND LINKAGE	S S	76 TIRES - *(Record pressure on page 6)*		139 PILOT VALVE, PRESSURESTAT	
64 GEAR HOUSING AND CAGES		78 WHEELS - Cracks, rim, rivets, hook, mirtle hook - Mountings, locks		141 AIR TOOLS AND ACCESSORIES	
65 GEARS AND PINIONS		79 AXLE BOLTS - Bearings, mountings	C C	142 INTER-COOLER, RELIEF VALVE ASSEMBLY - Lines, leaks	
66 BEARING AND SHAFTS		79 AXLE WHEELS - Bearings, mountings	C	143 LINE OILERS	
71 HYDRAULIC SYSTEM, TANK		80 FRAME - Cracks, welds, alignment		144 VALVES - Inlet, discharge	
72 CONTROL AND RELIEF VALVE ASSEMBLY		82 REAR AXLE ASSEMBLY		146 UNLOADERS -	
S S 76 TIRES - *(Record pressure on page 6)*		85 SPRINGS, EQUALIZERS, STABILIZERS - Brackets, shackles, mountings		CUT IN PRESSURE / CUT OUT PRESSURE	
80 FRAME - Cracks, welds, alignment	A A	89 SERVICE BRAKES - Parking brakes		146 CYLINDERS, HEADS, GASKETS - Leaks, cracks	
81 FRONT AXLE ASSEMBLY, ROLLERS, SCRAPERS		133 BRAKE AIR TANK - Valves, lines, mounting		147 CRANKCASE - Leaks, oil level	
82 REAR AXLE ASSEMBLY, ROLLERS, SCRAPERS		134 HYDRAULIC RESERVE TANK - Valves, lines, mounting		Oil pressure	
93 TRANSMISSION, TRANSFER CASE - Gaskets, seals, leaks, oil level		136 LANDING GEAR, JACKS	CS CS	148 GOVERNOR, AIR CLEANER - Linkage, mountings	
107 FINAL DRIVE - Mounting, seals, gaskets, leaks, oil level		137 RAMP, CARGO DECK, REAR KICK UP		173 CONTROLS, SWITCH GEAR, WIRING - Connections, mountings	
137 SPRINKLING SYSTEM - Tank, lines, mounting				216 ELECTRIC MOTORS - Wiring, connections, mounting	
205 SCARIFIER - Teeth, block and lift mechanism					

Page 2

Plate 16. Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment (DA Form 464), page 2.

SERIAL NUMBER

		TRACTORS WHEELED (W) CRAWLER (C)
		52 LIGHTS, WIRING, SWITCHES - Mountings, connections
		56 STEERING GEAR ASSEMBLY (W)
		59 REGULATOR, SAFETY VALVE, CHECK VALVE
		60 PUMPS AND DRIVES - Hydraulic, vacum, air, mountings
		61 VALVES, CYLINDERS, JACKS - Gaskets, seals, packing, leaks, lines
		62 LEVERS, PEDALS, LINKAGE, CABLES
		63 UNIVERSAL JOINTS, BALL JOINTS (W)
		64 GEAR HOUSING, CASES - Gaskets, seals, leaks
		65 GEARS AND PINIONS
		66 BEARINGS AND SHAFTS
A	A	67 POWER CONTROL UNITS - Drum, sheaves, clutches, brakes, shear pin
		68 DRUMS, SHEAVES, CABLES
		69 TIE RODS, LINKAGE, BOOTS AND SEALS (W)
		71 BOOSTER, STEERING ASSEMBLY
		72 HYDRAULIC TANK
		73 WINCH, CHAINS
5	5	76 TIRES - (Record pressure on page 6) (W)
		77 TOW HITCH, PINTLE HOOK
		80 FRAME - Cracks, welds, alinement
		81 FRONT AXLE ASSEMBLY, WHEELS - (W) Bearings, mountings
		82 REAR AXLE ASSEMBLY, WHEELS - (W) Bearings, mountings
		83 SPRINGS, EQUALIZERS, STABILIZERS - Bracket, shackles, mountings
		87 TRACK ASSEMBLIES - Plates, links, (C) bushings - pins
		88 IDLERS, ROLLERS - Springs, bushings, (C) bearings, seals, shafts, mountings
A	A	89 TRACK TENSION (C)
T	T	90 FRAMES AND GUARDS
		93 TRANSMISSION, TRANSFER CASE - Gaskets, seals, leaks, oil level
A	A	94 DRIVES, SPROCKETS, CHAINS, BELTS

		TRACTORS (Continued)
A	A	96 STEERING OR TRAVEL CLUTCHES
A	A	99 SERVICE BRAKE
A	A	100 EMERGENCY BRAKE, BRAKE LOCK
A	A	101 STEERING OR TRAVEL BRAKE (C)
		104 GEARS AND PINIONS - Cases, gaskets and seals, leaks
		105 BEARINGS AND SHAFTS - Gaskets and seals
		107 FINAL DRIVE - Housing, gaskets (C) and seals, leaks, oil level
		108 DRIVE SHAFTS AND U-JOINTS (W)
		131 CUTTING EDGES, END BITS
		132 POWER TAKE-OFF UNIT
		141 AIRLINES AND CONNECTIONS
		142 RELIEF VALVE, SAFETY VALVE - (Compressor) (W)
		144 VALVES - Inlet, discharge - (Compressor)
		145 UNLOADER - (Compressor) (W)
		146 CYLINDER HEAD GASKETS - (Compressor) - (W) Leaks, cracks, tightness
		147 HOSES AND PIPES - (Compressor) (W)
		148 AIR CLEANER - (Compressor) - (W) Leaks, connections and mounting
	T	165 "A" FRAME OR YOKE
		166 MOLD BOARDS - Pins, kingpin, pivot socket, bolts
		167 LIFT ARMS
		168 SIDE ARMS
		169 LIFT SHEAVE AND FRAME ASSEMBLY
		171 HYDRAULIC LINES AND CYLINDERS

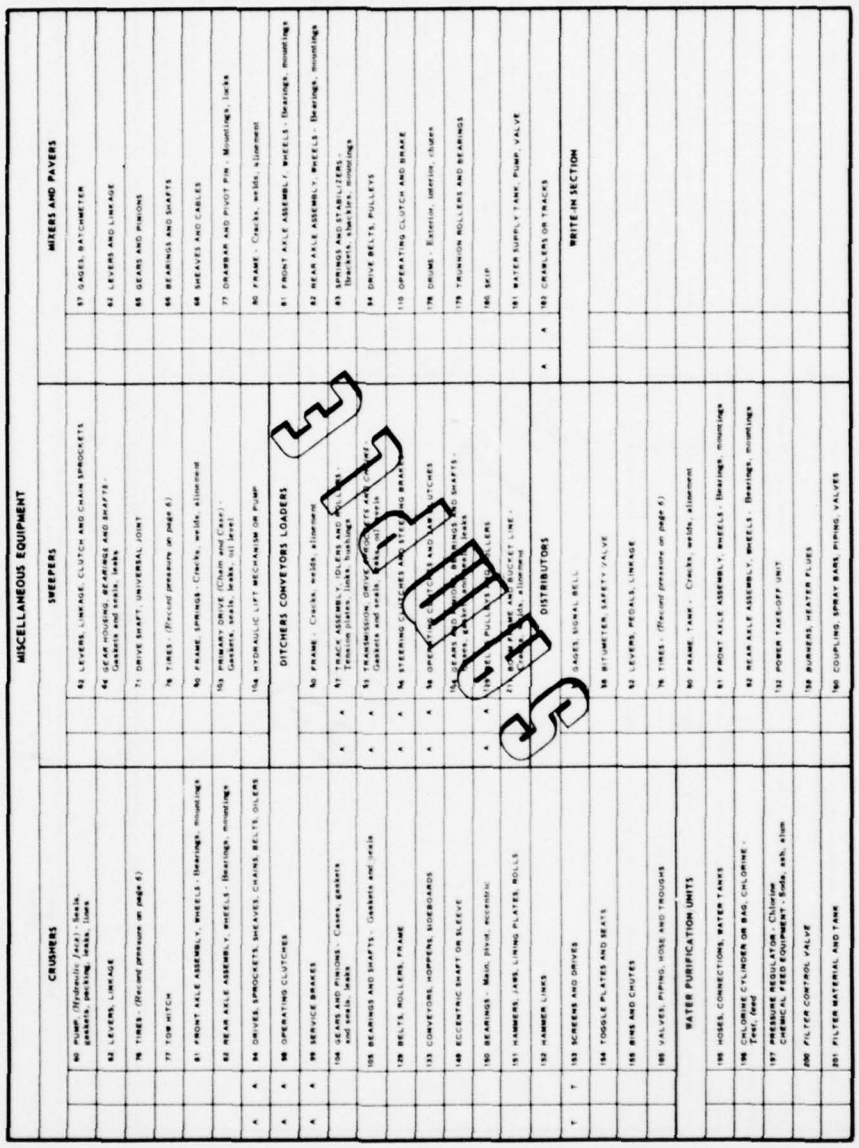
SAMPLE

		CRANES - SHOVELS CRAWLER (C) TRUCK MTD (T)
		52 LIGHTS, WIRING, SWITCHES - Mounting, connections
		56 STEERING GEAR ASSEMBLY (T)
		59 REGULATOR, SAFETY VALVE, CHECK VALVE
		60 PUMPS AND DRIVES - Hydraulic, vacum, air, mountings
		61 VALVE, CYLINDERS, JACKS - Gaskets, seals, packing, leaks, lines
		62 LEVERS, PEDALS, LINKAGE
		63 UNIVERSAL JOINTS, BALL JOINTS (T)
		64 GEAR HOUSING CASES - Gaskets, seals, leaks
		66 BEARINGS AND SHAFTS
		68 DRUMS, SHEAVES, CABLES
		69 TIE RODS, LINKAGE, BOOTS AND SEALS (T)
		70 FULCRUM ARMS, REACH ARMS, LINKAGE
		71 HYDRAULIC CONTROL SYSTEM
		72 RELIEF VALVES
		73 AIR COMPRESSOR
5	5	76 TIRES - (Record pressure on page 6) (T)
		80 FRAME - Cracks, welds, alinement
		81 FRONT AXLE ASSEMBLY, WHEELS - (T) Bearings, mountings
		82 REAR AXLE ASSEMBLY, WHEELS - (T) Bearings, mountings
		83 SPRINGS, EQUALIZERS, STABILIZERS - Bracket, shackles, mountings
		84 HOODS, PANELS, DOORS
		87 TRACK ASSEMBLIES - Plates, links, (C) bushings - pins
		88 IDLERS AND ROLLERS - Springs, bushings, bearings, seals, shafts, mountings
A	A	89 TRACK TENSION
		90 FRAME, GUARDS, OUTRIGGERS
		93 TRANSMISSION AND TRANSFER CASE - Gaskets, seals, leaks, oil level
A	A	94 DRIVE SPROCKETS, CHAINS AND BELTS
A	A	96 STEERING OR TRAVEL CLUTCHES

Page 3

Plate 17. Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment (DA Form 464), page 3.

Plate 18. Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment (DA Form 464), page 4.



MISCELLANEOUS EQUIPMENT

CRUSHERS

80 PUMP: (Hydraulic (Jaw): Seals, gaskets, packing, hoses, lines
82 LEVERS, LINKAGE
96 TIRES: (Record pressure on page 6)
77 TOW HITCH
81 FRONT AXLE ASSEMBLY, WHEELS: Bearings, mountings
82 REAR AXLE ASSEMBLY, WHEELS: Bearings, mountings
A A 84 DRIVES, SPROCKETS, SHEAVES, CHAINS, BELTS, OILERS
A A 88 OPERATING CLUTCHES
A A 89 SERVICE BRAKES
104 GEARS AND PINIONS: Cases, gaskets and seals, leaks
105 BEARINGS AND SHAFTS: Gaskets and seals
120 BELTS, ROLLERS, FRAME
133 CONVEYORS, HOPPERS, SIDEBOARDS
140 ECCENTRIC SHAFT OR SLEEVE
150 BEARINGS: Main, pitman
151 HAMMERS, JAWS, LINING PLATES, ROLLS
152 HAMMER LINKS
T T 153 SCREENS AND DRIVES
154 TOGGLE PLATES AND SEATS
155 BINS AND CHUTES
180 VALVES, PIPING, HOSE AND TROUGHS

WATER PURIFICATION UNITS

190 HOSES, CONNECTIONS, WATER TANKS
196 CHLORINE CYLINDER OR BAG, CHLORINE: Feed, feed
197 PRESSURE REGULATOR: Chlorine
CHEMICAL FEED EQUIPMENT: Soda, ash, alum
200 FILTER CONTROL VALVE
201 FILTER MATERIAL AND TANK

SWEEPERS

82 LEVERS, LINKAGE, CLUTCH AND CHAIN SPROCKETS
84 GEAR HOUSING, BEARINGS AND SHAFTS: Gaskets and seals, leaks
71 DRIVE SHAFT, UNIVERSAL JOINT
76 TIRES: (Record pressure on page 6)
80 FRAME, SPRINGS: Cracks, welds, alignment
105 PRIMARY DRIVE (Chain and Case): Gaskets, seals, leaks, oil level
104 HYDRAULIC LIFT MECHANISM OR PUMP

DITCHERS CONVEYORS LOADERS

80 FRAME: Cracks, welds, alignment
A A 87 TRACK ASSEMBLY, IDLERS AND ROLLERS: Tension plates, links, bushings
A A 93 TRANSMISSION, DRIVE SPROCKETS AND CHAIN: Gaskets and seals, transmission chain
A A 96 STEERING CLUTCHES AND BRAKES AND BRAKES
A A 98 OPERATING CLUTCHES AND BRAKES
A A 104 GEARS AND PINIONS: Cases, gaskets and seals, leaks
BEARINGS AND SHAFTS: Gaskets and seals, leaks
A A 120 BELTS, PULLEYS, ROLLERS
FRAME AND BUCKET LINE: Cracks, welds, alignment

DISTRIBUTORS

GAGES, SIGNAL BELL
BITUMETER, SAFETY VALVE
LEVERS, PEDALS, LINKAGE
TIRES: (Record pressure on page 6)
FRAME, TANK: Cracks, welds, alignment
FRONT AXLE ASSEMBLY, WHEELS: Bearings, mountings
REAR AXLE ASSEMBLY, WHEELS: Bearings, mountings
POWER TAKE-OFF UNIT
BURNERS, HEATER FLUES
COUPLING, SPRAY BARS, PIPING, VALVES

MIXERS AND PAVERS

GAGES, BATCHMETER
LEVERS AND LINKAGE
GEARS AND PINIONS
BEARINGS AND SHAFTS
SHEAVES AND CABLES
DRAWBAR AND PIVOT PIN: Mountings, locks
FRAME: Cracks, welds, alignment
FRONT AXLE ASSEMBLY, WHEELS: Bearings, mountings
REAR AXLE ASSEMBLY, WHEELS: Bearings, mountings
SPRINGS AND STABILIZERS: Brackets, shackles, mountings
DRIVE BELTS, PULLEYS
OPERATING CLUTCH AND BRAKE
DRUMS: Exterior, interior, chutes
TRUNNION ROLLERS AND BEARINGS
SKIP
WATER SUPPLY TANK, PUMP, VALVE
A A CRAWLERS OR TRACKS

WRITE-IN SECTION

Page 5

Plate 19. Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment (DA Form 464), page 5.

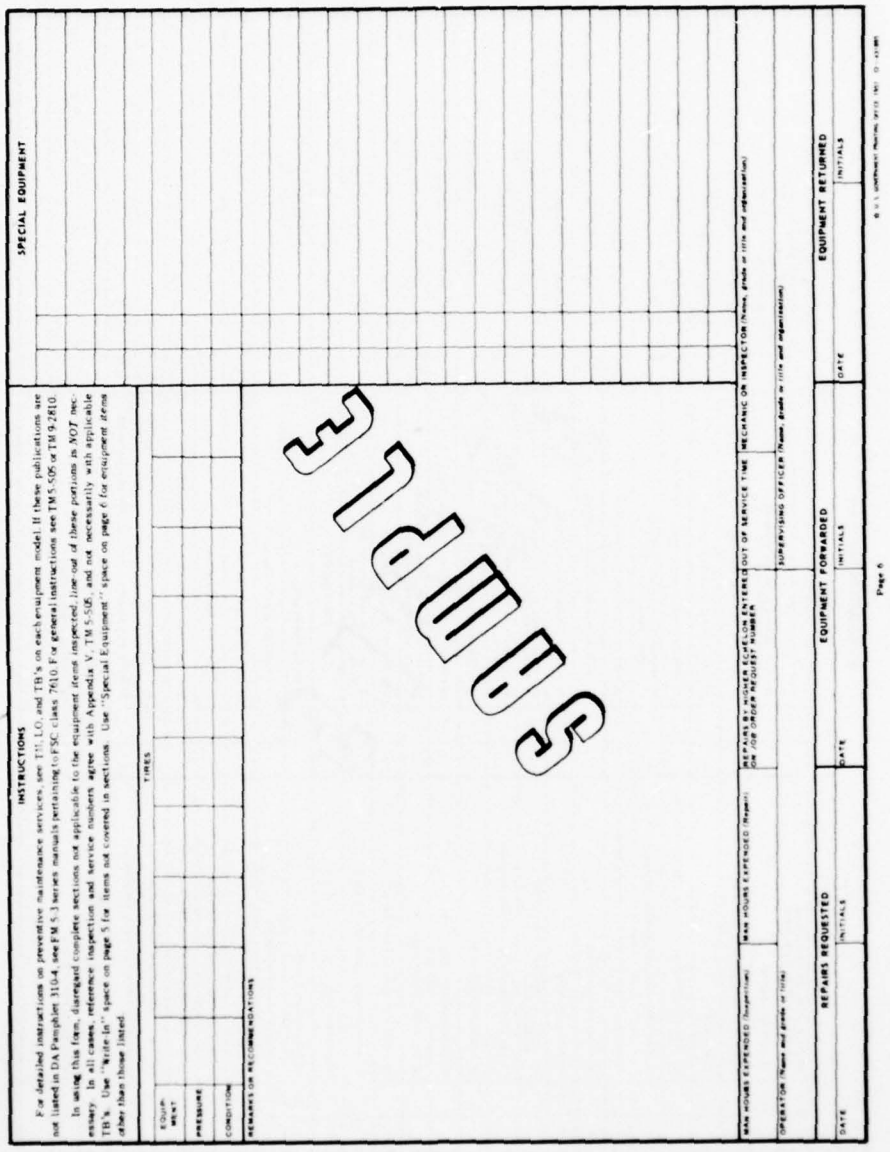


Plate 20. Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment (DA Form 464), page 6.

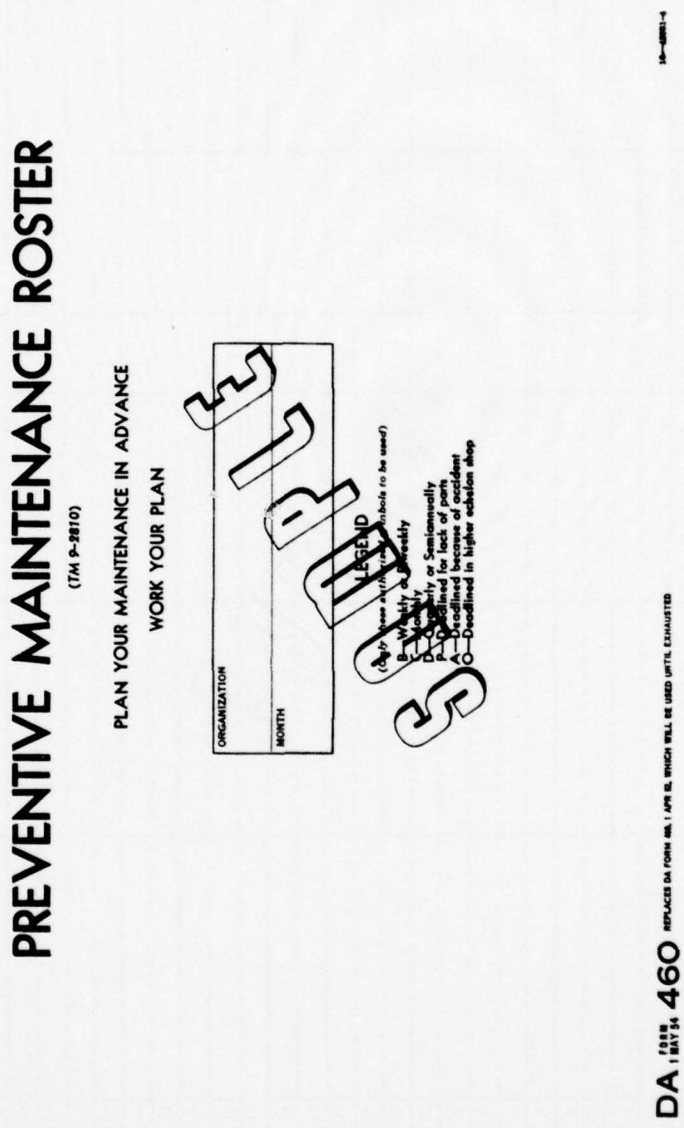


Plate 21. Preventive Maintenance Roster (DA Form 460), cover.

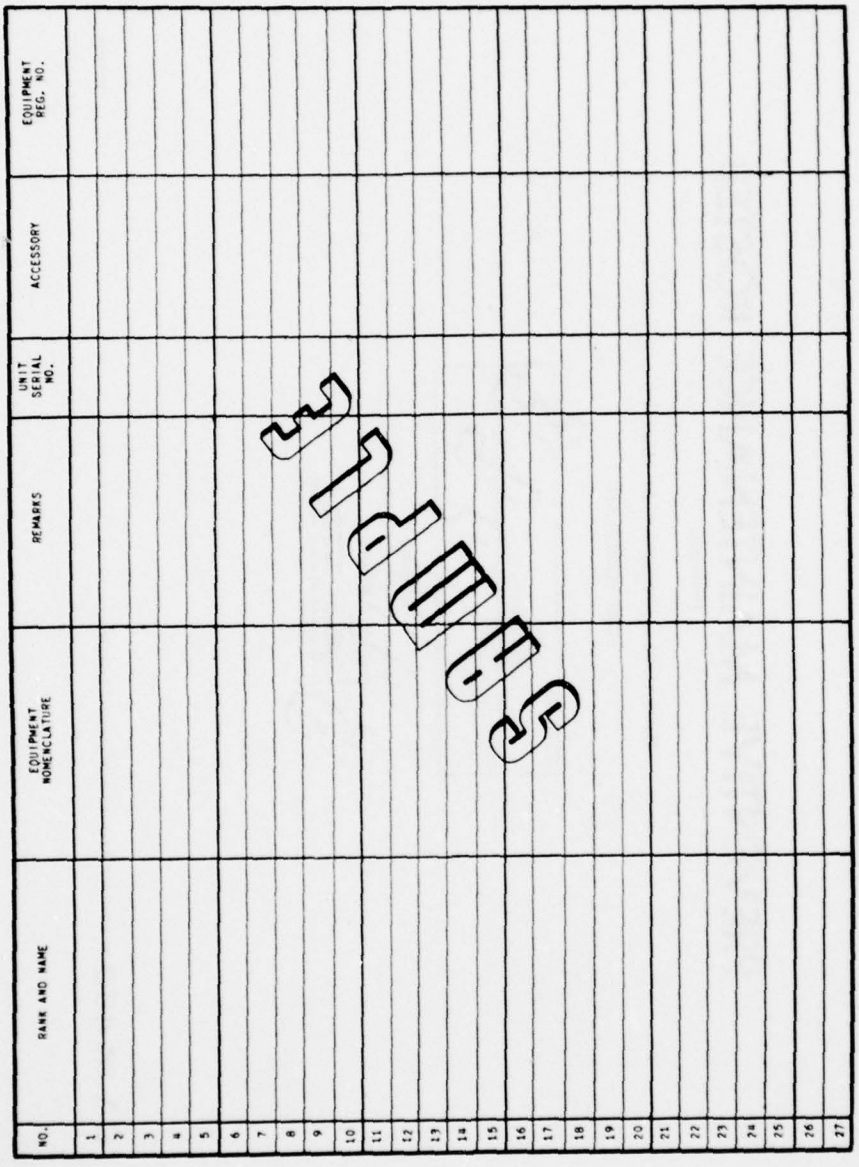


Plate 22. Preventive Maintenance Roster (DA Form 460), page 2.

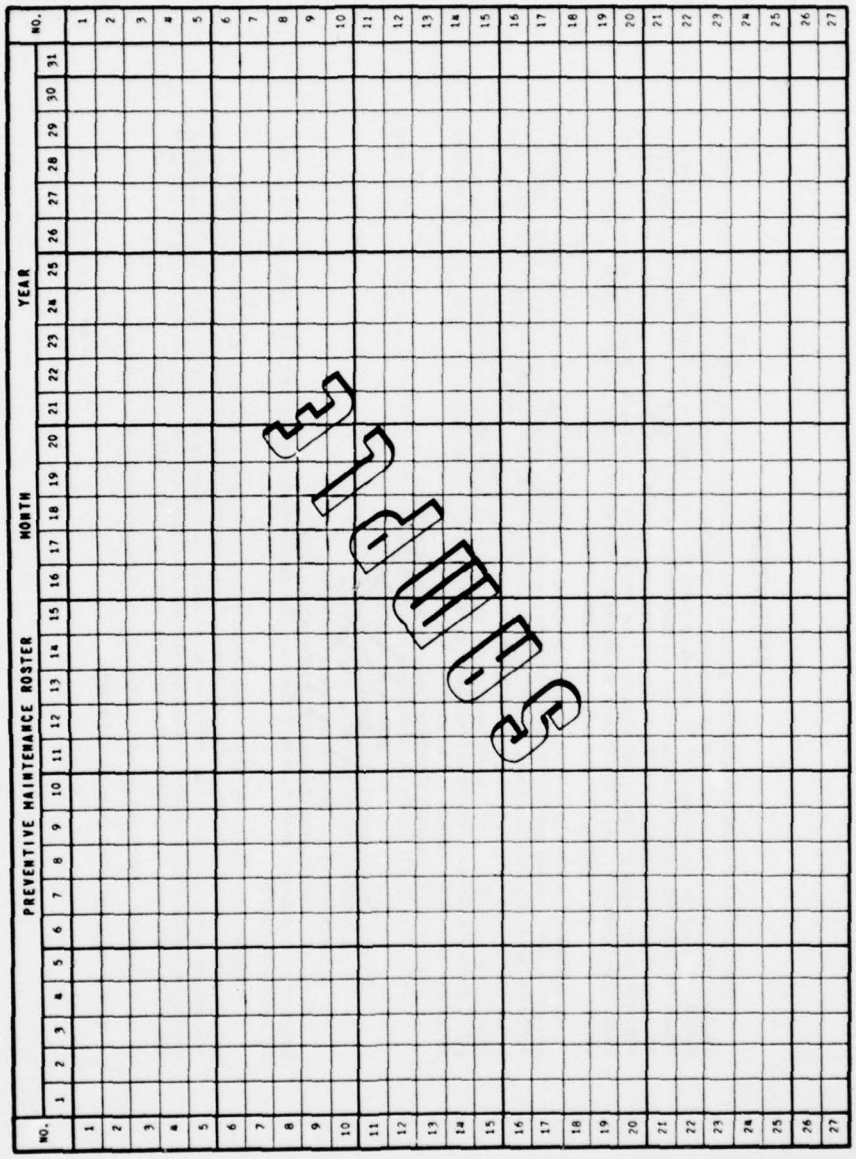


Plate 23. Preventive Maintenance Roster (DA Form 460), page 3.

INSTRUCTIONS

1. APPLICATION.—Preventive maintenance services are prescribed at various intervals (daily, weekly, monthly, quarterly, and semiannually), and must be systematically scheduled, performed, and recorded on regular cycles. TM 9–2810 prescribes the use of this form for scheduling preventive maintenance on the following types of equipment: Wheeled vehicles; track-laying, combined wheel and track-laying vehicles; chassis powered by self-contained power units; trailers and semitrailers towed by vehicles; *motorcycles; motor scooters; bicycles;* amphibians; materials handling equipment; engineer construction equipment; Air Force motorized equipment; ground power equipment; and similar type equipment. Use of this form is not required on aircraft, stationary engineer equipment, animal-drawn vehicles, or transport vehicles operating exclusively on rails or water.

2. METHOD OF SCHEDULING.—Equipment will be listed in the roster and scheduled with the prescribed symbol services, *in pencil,* one full month of 31 days in advance, showing date and nature of services due. Only a single line will be used for each piece of equipment. Accessory items pertaining to or serviced with each piece of equipment, such as trailers, will be identified by placing the USA Registration or other pertinent identifying number in the "accessory" column on the same line. Both a steady maintenance load and the maximum utility of equipment are obtained by staggering equally the various maintenance schedules among the available working days of the month. Only the following authorized maintenance symbols will be used:

B1, B2, B3: to designate successive *weekly* maintenance services.
C1, C2, or *C1, C2, C3, C4, C5: to designate successive monthly services following a quarterly* or semiannual service, respectively.
D: to designate quarterly or semiannual maintenance services.
P: to indicate equipment deadlined for lack of parts.
A: to indicate equipment deadlined because of accident.
O: to indicate equipment deadlined in higher echelon shops.

Quarterly and semiannual services are not numbered. The spaces between scheduled services will remain blank except for authorized symbols.

3. PERFORMANCE.—The motor officer, motor sergeant, or other designated authority will examine the roster daily and take appropriate action to insure the performance of the scheduled services. When a service is performed as scheduled, the symbol will be traced in *ink.* When, due to unforeseen circumstances, the performance of a service is delayed, the original penciled symbol will be *circled* and traced in ink; subsequent services will be scheduled from the scheduled date of the circled symbol, regardless of the date when the service was actually performed.

4. DISPOSITION.—TM 12–259 provides this form may be destroyed 6 months after completion.

5. For additional information, see TM 9–2810.

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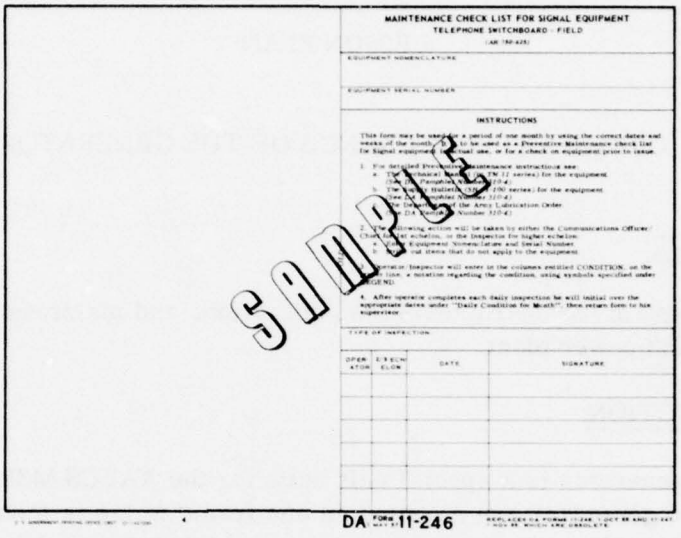
Plate 24. Preventive Maintenance Roster (DA Form 460), page 4.



MAINTENANCE CHECK LIST FOR SIGNAL EQUIPMENT
TELEPHONE SWITCHBOARD - FIELD

EQUIPMENT NOMENCLATURE

EQUIPMENT SERIAL NUMBER

INSTRUCTIONS

This form may be used for a period of one month by using the correct dates and weeks of the month. It is to be used as a Preventive Maintenance check list for Signal equipment in actual use, or for a check on equipment prior to issue.

1. For detailed Preventive Maintenance instructions see:
   a. The Technical Manual (TM 11 series) for the equipment.
   b. The Signal Pamphlet (SIG 310-4.
   c. The Signal Bulletin (SIG 310 series) for the equipment.
   d. The Lubrication Order (SIG 310-4).
   e. The Department of the Army Lubrication Order.
   f. The DA Manual (DA Number 310-4).

2. The following action will be taken by either the Communications Officer, Chief Signal echelon, or the Inspector for higher echelon:
   a. Check Equipment Nomenclature and Serial Number.
   b. Delete all items that do not apply to the equipment.

3. The Operator or Inspector will enter in the columns entitled CONDITION, on the reverse side, a notation regarding the condition, using symbols specified under LEGEND.

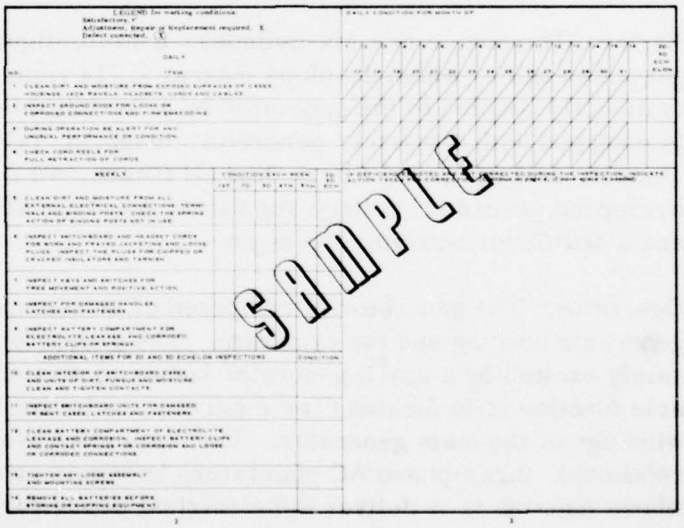
4. After operator completes each daily inspection he will initial over the appropriate dates under "Daily Condition for Month", then return form to his supervisor.

TYPE OF INSPECTION

OPERATION	ECHELON	DATE	SIGNATURE

DA FORM 11-246

(1) DA Form 11-246, front.



LEGEND for making conditions:
Satisfactory, S
Adjustment, Repair or Replacement required, X
Defect corrected, C

DAILY DAILY CONDITION FOR MONTH OF

NO.	ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1ST ECH ECHELON	2D ECH ECHELON
1	CLEAN DIRT AND MOISTURE FROM EXPOSED SURFACES OF CASES, HOUSINGS, JACK PANELS, HEADSETS, CORDS AND CABLES																																	
2	INSPECT GROUND WIRE FOR LOOSE OR CORRODED CONNECTIONS AND FOR CHAFED SPOTS																																	
3	DURING OPERATION BE ALERT FOR ANY UNUSUAL PERFORMANCE OR CONDITION																																	
4	CHECK CORD REELS FOR FULL RETRACTION OF CORDS																																	

WEEKLY

	CONDITION EACH WEEK							1ST ECH ECHELON	2D ECH ECHELON
	1ST	TO	TO	TO	TO	TO	TO		
5 CLEAN DIRT AND MOISTURE FROM ALL EXTERNAL ELECTRICAL CONNECTIONS, TERMINALS AND BINDING POSTS. CHECK THE SPRING ACTION OF BINDING POSTS NOT IN USE									
6 INSPECT SWITCHBOARD AND HEADSET CORDS FOR WORN AND FRAYED INSERTING AND LISTING PLUGS. INSPECT THE PLUGS FOR CHIPPED OR CRACKED INSULATORS AND TARNISH									
7 INSPECT KEYS AND KEYSHAFTS FOR FREE MOVEMENT AND POSITIVE ACTION									
8 INSPECT FOR DAMAGED HANDLES, LATCHES AND FASTENERS									
9 INSPECT BATTERY COMPARTMENT FOR ELECTROLYTE LEAKAGE AND CORRODED BATTERY CLIPS OR SPRINGS									

ADDITIONAL ITEMS FOR 2D AND 3D ECHELON INSPECTIONS	CONDITION
10 CLEAN INTERIOR OF SWITCHBOARD CASES AND UNITS OF DIRT, FUNGUS AND MOISTURE. CLEAN AND TIGHTEN CONTACTS	
11 INSPECT SWITCHBOARD UNITS FOR DAMAGED OR MISSING CASES, LATCHES AND FASTENERS	
12 CLEAN BATTERY COMPARTMENT OF ELECTROLYTE LEAKAGE AND CORROSION. INSPECT BATTERY CLIPS AND CONTACT SPRINGS FOR CORROSION AND LOOSE OR CORRODED CONNECTIONS	
13 TIGHTEN ANY LOOSE ASSEMBLY AND MOUNTING SCREWS	
14 REMOVE ALL BATTERIES BEFORE STORING OR SHIPPING EQUIPMENT	

(2) DA Form 11-246, back.

Plate 25. Maintenance Check List for Signal Equipment: Telephone Switchboard-Field (DA Form 11-246).

IM-8

LESSON PLAN

CARE AND MAINTENANCE OF THE GENERATOR

OBJECTIVE:

To explain the characteristics, operation, and maintenance of the AAFCS M33 power plant.

INTRODUCTION:

The generator is a special unit built for the AAFCS M33. Both the engine and generator are mounted on one frame which is mounted on a two-wheel trailer. Proper maintenance and lubrication of the unit is very important because of the high amount of voltage and frequency precision required of the power plant.

1. Engine: The engine is a six-cylinder, L-head, liquid-cooled gasoline engine, which develops 60hp at 1, 714 rpm, and which is directly coupled to the generator by a flexible coupling. It is equipped with a starter, generator, magneto, oil-bath air cleaner, fuel pump and filter, dual oil filters, oil cooler, overspeed governor, voltage regulator, mechanical governor, and a heater for warming the engine.

2. Generator: The generator is composed of two components: the generator housing and the armature. The generator is separately excited by a small generator known as an exciter, whose sole function is to furnish direct-current excitation for the field windings of the main generator. The main generator is a Y-connected, three-phase AC generator, known as an alternator, whose function is to deliver the electrical power for the AAFCS M33.

PRESENTATION:

1. Control Panel.

The control panel, mounted at the rear of the unit, contains all the equipment necessary for the control of the power unit. The panel is divided into two parts.

a. The upper portion of the panel contains controls for the operation of the generator. These are an hour meter, voltage regulator, frequency meter, voltmeter, ammeter, synchronizing lights, synchronizing lights toggle switch, 24 volt-light toggle switch, emergency overload button, meter switch, two double 120 volt receptacles, regulator rheostat, telephone jack, field rheostat, 24 volt receptacle, start-stop push button, a pilot light, and a remote-local voltage control switch.

b. The lower portion of the panel contains controls and instruments for the operation of the engine. These are a fuel primer for the engine, choke, starter push button, battery-charging ammeter, oil pressure gauge, temperature gauge, throttle, speed control, and a three-position ignition switch.

c. The upper portion of the control panel is hinged and will open to provide access to the inside of the panel.

d. The output terminals to T1, T2, and T3 are located just below the engine control panel.

2. Engine Controls and Instruments.

a. Primer.

1) The PRIMER knob is mounted on the left side of the lower control panel and is meant for use only in cold weather, as an aid to starting.

2) This knob injects raw fuel directly into the intake manifold.

b. Choke.

1) The choke is located just to the right of the primer and should be used when starting a cold engine.

2) Pull the choke all the way out when starting.

3) When the engine starts, push the choke in until the engine runs smoothly. As the engine warms up, push the choke all the way in.

c. STARTER Push Button.

1) The STARTER push button is located just to the right of the choke and is identified by a name plate.

2) To start the engine, push this button momentarily, then release it.

d. BATTERY-CHARGING Ammeter.

1) The ammeter is located just to the right of the STARTER push button.

2) It is a center-reading meter and registers the amount of electricity flowing into or out of the battery.

3) It indicates the charging condition of the generator and the consumption of electricity in the system.

e. OIL PRESSURE Gauge.

1) The OIL PRESSURE gauge is located just to the right of the BATTERY-CHARGING ammeter, and it is calibrated in pounds of pressure from 0 to 60.

2) In normal operation, the gauge should register between 15 and 40 pounds pressure.

f. WATER TEMPERATURE Gauge.

1) The WATER TEMPERATURE gauge is located just to the right of the OIL PRESSURE gauge and is calibrated in degrees from 100° to 220° F.

2) The engine should always be run at between 160° and 180° F.

g. Throttle.

1) The throttle is located to the right of the TEMPERATURE gauge.

2) When the throttle control is all the way in, it is in its normal operating position.

3) To idle the engine, pull the throttle out.

h. Speed Control.

1) The ENGINE SPEED control is just to the right of the throttle.

2) Pushing in this control will result in increased engine speed. After the engine speed is set, the control can be turned in a clockwise direction and locked in place.

i. IGNITION Switch.

1) The IGNITION switch is located on the right edge of the engine control panel.

2) It is a three-position switch with positions OFF, START, and RUN.

3. Generator Controls and Instruments.

a. FREQUENCY Meter.

1) The FREQUENCY meter is located just to the right of the HOUR meter.

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AAFCS M33 TECHNICIAN TRAINING PROGRAM. VOLUME VI. MAINTENANCE A--ETC(U)
JUN 58 DA-49-106-QM-1

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NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

2) It indicates the number of cycles per second and is graduated in 5-cycle steps from 380 to 420 cycles per second.

b. AC Voltmeter.

1) The voltmeter is located at the top of the panel just to the left of the ammeter and is provided to measure the voltage of the main generator output.

2) It is a double-scale meter with graduations from 0 to 300 volts and from 0 to 600 volts.

3) The voltage of any phase can be read by the use of the METER switch.

c. AC Ammeter.

1) An AC ammeter is provided, just to the right of the voltmeter, to indicate the current of the main generator output.

2) It is a double-scale meter with ranges from 0 to 150 amperes and 0 to 75 amperes.

d. METER Switch.

1) The METER switch is located just below the voltmeter.

2) It provides for the reading of voltage and amperage, directly on the meters, of the phase indicated by the METER switch.

e. FIELD CONTROL Rheostat.

1) The FIELD CONTROL rheostat is located in the lower center of the upper panel.

2) It is an adjustable resistance unit and provides manual regulation of the voltage output of the main generator.

3) This rheostat regulates the output voltage only when the REGULATOR switch is at OFF.

f. Regulator Rheostat.

1) The VOLTAGE REGULATOR rheostat, located just to the left of the FIELD CONTROL rheostat, provides for adjustment of the voltage only when the VOLTAGE REGULATOR switch is at the ON position.

2) This voltage, after it is set, is maintained by the regulator.

g. MAIN SWITCH Push Buttons.

1) These buttons are located in the lower right corner of the upper control panel. The ON button is black; the OFF button is red.

2) The operation of these buttons applies the load to the generator or removes the load from it.

h. SYNCHRONIZING LIGHTS Toggle Switch.

1) The SYNCHRONIZING LIGHTS toggle switch is located on the left side of the upper control panel and controls the SYNCHRONIZING lights.

i. PANEL LIGHT Toggle Switch.

The PANEL LIGHT toggle switch is located just to the right of the SYNCHRONIZING LIGHTS toggle switch and turns the PANEL ILLUMINATING lights on or off as desired.

j. VOLTAGE REGULATOR Toggle Switch.

1) The VOLTAGE REGULATOR toggle switch is located just to the right of the 24 VOLT LIGHT toggle switch.

2) It provides for automatic voltage regulation by the VOLTAGE REGULATOR when in ON position and manual regulation with the FIELD CONTROL rheostat when in OFF position.

k. EMERGENCY OVERLOAD Push Button.

1) The EMERGENCY OVERLOAD push button is located just to the right of the VOLTAGE REGULATOR toggle switch.

2) This button should be used only in emergency to hold the main contactor ON when the circuit breaker is overloaded.

l. 24 Volt Receptacle.

1) The 24 volt receptacle, located just to the left of the METER switch, provides 24 volt current direct from the batteries for an extension cord with trouble light.

m. UNIT-PARALLEL Toggle Switch.

1) This switch is located just to the right of the METER switch.

2) It must be in UNIT position when operating a single unit.

3) It must be in PARALLEL position on each unit when operating two or more units in parallel.

n. 120 Volt Receptacles.

1) Two double, 120 volt receptacles are located in the lower left corner of the upper control panel.

One double receptacle is for two-pronged plugs while the other receptacle is for a grounded three-pronged plug.

2) These receptacles serve as a means for obtaining power from the main generator to operate 110 volt lights and tools.

3) The load on each receptacle should be limited to 15 amperes.

o. Telephone Jack.

A telephone jack is located just to the right of the 120 volt receptacle to provide communication between installations. The telephone wires are incorporated in the 28-conductor power cable.

p. LOCAL-REMOTE Toggle Switch.

1) This switch, located just to the right of the telephone jack, provides for automatic voltage regulation from the AAFCS M33 trailer when in REMOTE position.

2) Two jumpers on either side of this switch should be removed only when the equipment to which power is being supplied is equipped for remote control. At all other times the jumpers should be in place.

q. PILOT Light.

The PILOT light is a neon light that is illuminated whenever the main contactor is closed.

4. Normal Operation.

a. Before Operations Check.

1) Check for adequate supply of fuel, oil, and coolant.

2) Make a visual inspection of the unit, checking for leaks, loose wires, cleanliness, and general appearance.

3) Properly position the three-way, fuel line, cutoff valve for operation.

b. Starting the Engine.

1) Place the LOCAL-REMOTE switch in LOCAL position, UNIT-PARALLEL switch in UNIT position, and VOLTAGE REGULATOR toggle switch in OFF position.

2) Turn the IGNITION switch to START; pull out throttle approximately halfway.

3) Press the START button until engine starts. Use choke if necessary. Cold starting of the engine is possible to 0° F. For procedure under extreme cold conditions, see Par. 5 below.

4) Let the engine run with no load until the TEMPERATURE gauge indicates a minimum of 140° F.

c. Application of Power.

1) Check cable connections from AAFCS M33 trailer to receptacles on unit.

Note: Both cables must be connected before turning on power.

2) Push throttle in all the way.

3) Turn FIELD CONTROL rheostat until voltmeter indicates 208 volts with METER switch; check all three phases.

Note: METER switch must not be in 1-0 position for adjustment.

4) With ENGINE SPEED control, adjust frequency to 405-410 cycles (before loading). Turn handle clockwise to lock.

5) Readjust FIELD CONTROL rheostat until voltmeter indicates 208 volts. With METER switch, check all three phases.

6) Turn VOLTAGE REGULATOR switch to ON position.

7) Turn field regulator rheostat until voltmeter indicates 208 volts.

8) Apply load by pushing MAIN SWITCH push button to close main switch.

9) Place LOCAL-REMOTE switch to REMOTE; then, voltage is controlled from trailer.

d. During Operations Check.

1) Check TEMPERATURE gauge and OIL PRESSURE gauge for proper indications.

2) Check for leaks or any unusual noise or condition.

e. Stopping the Engine.

1) De-energize AAFCS M33.

2) Plate LOCAL-REMOTE switch to LOCAL.

Note: It is extremely important that this switch be placed in the LOCAL position before power is cut off.

3) Depress OFF push button to turn off power.

4) Turn VOLTAGE REGULATOR rheostat counterclockwise to MINIMUM position.

5) Place VOLTAGE REGULATOR switch to OFF.

6) Turn ENGINE SPEED control counterclockwise to unlock, and allow it to return to position.

7) Pull out throttle, and idle engine for several minutes. (Engine side panels should be open during this idling period.)

8) Turn ignition off.

5. Operation Under Extreme Cold (0° to -65° F).

a. General.

Operation of electrical generating units at subzero temperatures requires special precautions and extra servicing from both operation and maintenance personnel if good performance is to be achieved and total functional failure avoided. Equipment can be more satisfactorily operated in extremely cold weather if the following precautions are observed.

b. Distributor.

1) The distributor breaker points should be checked for cleanliness and squareness and set at an operating gap of .020 inch.

2) The breaker arm must be resting on the high point of the cam during this operation.

c. Spark Plugs.

Remove the spark plugs and clean thoroughly, setting the gaps to .025 inch. If the electrodes are badly burned or pitted, replace with new plugs, being sure to use the same type and length of plugs as the original.

d. Fuel System and Fuel.

1) The carburetor should be cleaned.

2) Gasoline lines, fuel pump, and gasoline tank should be clean and free from water.

3) Care should be taken that there are no pockets in the lines in which water can collect and freeze, shutting off or reducing the flow of fuel.

a) Water may get into the glass filter bowl, freeze, and crack it; therefore, this filter should be inspected daily.

b) Fuel storage and fuel handling require extreme care to avoid trouble with moisture. Strain fuel to remove water. Keep fuel tanks and drums as nearly full as possible to avoid moisture condensation from the air space above the fuel level. Add a pint of denatured alcohol to fuel tanks or drums each time they are refilled to reduce the possibility of ice formation in the fuel.

4) One of the major causes of winter engine trouble is use of an overrich mixture caused by changing the carburetor adjustment. This causes excessive carbon deposits, dirty and wet spark plugs, and crankcase oil dilution. The unburned fuel finds its way past the piston rings (often causing them to stick), washes the lubricating oil off the cylinder walls, and dilutes the oil in the crankcase. This destroys its lubricating qualities and results in excessive wear of all moving parts of the engine.

5) Be sure fuel containers are clean and free from rust.

a) If possible, after filling or moving container, allow fuel to settle before using.

b) Never draw operating fuel from the extreme bottom of the containers.

6) If operating out-of-doors, take steps to prevent entry of snow, water, and ice into fuel containers.

e. Lubrication.

1) The lubrication of the engine requires special consideration for subzero operation.

a) Check the oil frequently for sludge and water. Water condenses, collects quickly, mixes with oil, and increases carbon deposits to form a sludge. Water in the crankcase may freeze and shut off the oil supply or do serious damage to the oil pump.

b) Drain the oil more frequently. The engine crankcase should be drained while the engine is hot. It should be refilled with a lighter grade of oil than that used in warm weather.

2) One essential requirement is that the oil viscosity be maintained at a normal value.

a) This is accomplished by means of the integrally installed coolant heater. This heater, by thermal action, forces heated coolant fluid through the water jacket of the engine.

b) In addition, heated air is forced around the jacketed crankcase and batteries. The heat radiation from the heater and tubes serves to raise the temperature of the air within the canopy.

3) Subzero operation of the coolant heater.

a) In one hour, the coolant heater heats the oil and all required parts of the engine to the temperatures necessary to permit unassisted starting of the unit with surrounding temperatures down to -65° F.

b) To start the flow of gasoline to the heater, open the needle valve at the fuel strainer (on heater side of unit).

c) Place the HEATER TEMPERATURE CONTROL handle in HI position.

d) Hold the HEATER CONTROL switch in START position for 15 or 20 seconds, until gasoline ignites, then place switch in RUN position.

e) For a stand-by, place HEATER TEMPERATURE CONTROL handle in LO position.

f) To stop, place HEATER TEMPERATURE CONTROL handle in OFF position, and, in 3 to 5 minutes, place the ELECTRIC CONTROL toggle switch in OFF position. Close needle valve at the fuel strainer.

f. Battery.

1) The battery efficiency decreases sharply with decrease in temperature. Make certain the battery is fully charged before attempting subzero starting.

2) If necessary, use an auxiliary battery for starting.

3) Maintain the specific gravity of the battery between 1.275 and 1.300.

6. Operating Under Extremely Dusty Conditions.

a. General.

Operation of electrical generating units in extremely dusty conditions requires special precautions and extra servicing by both operation and maintenance personnel. If the following suggestions are carefully observed, more satisfactory operation under dusty conditions will be obtained.

b. Panel Doors.

1) The panel doors except doors covering the control panel must be kept closed whenever possible during operation, as a protection from dust.

2) If the unit is to be operated under dusty, out-of-doors conditions, locate the unit in a sheltered area if possible. Take advantage of any natural barriers which may offer protection from blowing dust.

3) If the installation is more than temporary, erect a protective shield.

c. Fuel-Pump Sediment Bowl.

Drain fuel-pump sediment bowl frequently, and keep all fuel containers covered and protected against dust entry.

d. Oil Filters and Air Cleaner.

1) The oil filters and air cleaner need more frequent attention.

2) Check oil-filter cartridge and air-cleaner element daily. Replace oil-filter cartridge as needed. Wash element, and change oil in air cleaner as required.

e. Crankcase.

1) The crankcase oil level should be observed frequently. Dusty conditions tend to load crankcase with dirt.

2) Watch for dirty and gritty oil conditions, and change oil as frequently as required.

7. Generator Lubrication.

a. Bearings.

The generator bearings of this unit are sealed bearings and therefore require no lubrication after installation.

b. Starter and Generator.

The starter and generator are equipped with oil impregnated, porous, bearings that require no lubrication.

c. Governor.

The governor is lubricated from the timing gear case.

d. Synchro-Start Overspeed Governor.

The overspeed governor should be lubricated with SAE 10 oil, through an oil cup on the side, every 25 hours of operation.

e. Air Cleaner.

Clean and refill oil reservoir. There must be no oil at all in the reservoir when the surrounding temperature is 0° F or below.

f. Oil Filters.

Replace cartridge every 300 hours of operation.

g. Magneto.

1) Every 1, 000 hours, lubricate magneto cam wick with 5 drops of OGP.

2) Repack bearings with OGH at each overhaul period.

h. Engine Crankcase.

1) Check oil level daily. Add oil if necessary.

2) Drain and refill with OE every 50 hours of operation (use SAE 30 for temperature above 0° F , SAE 10W for temperatures below 0° F).

i. Trailer.

1) Lubricate springs and shackles monthly with CG1 above 32° F , and CGO below 32° F.

2) Repack wheel bearings every six months with WB.

9. Maintenance Check Every Eight Hours of Operation (Minimum).

a. Check all parts for actual, or signs of impending, failure. Defective parts should be replaced.

b. Inspect all tubing and pipe lines for leaks. Joints and fittings must be tested for tightness. Gaskets must be replaced when necessary.

c. Check engine oil-level and condition of oil, and pressure on gauge.

d. Check battery water-level and battery ammeter for rate of charge.

e. Check radiator water-level and antifreeze solution in cold weather.

10. Maintenance Check Every 50 Hours of Operation (Minimum).

a. Inspect engine oil-filters for sludge.

b. Inspect all wires and terminals for damage, wear, and looseness.

c. Check spark plug electrode spacing and conditions. Set gap at 0.025 inch.

d. Check fan belt for proper tension: 1/2 to 3/4 inches deflection between pulleys.

e. Check fuel pump and carburetor for leaks or worn gaskets.

f. Check all parts for actual or potential failure. Defective parts must be replaced.

g. All instruments and switches must be subjected to a thorough examination and test.

11. Monthly Maintenance Services.

a. Inspect brushes for signs of wear, proper spring pressure, and freedom of action in holder. Examine brush holders to see that they are clean.

b. Check cummutator for roughness and for low, high, or loose bars.

When the unit is operated under dust-laden conditions, the commutator and collector rings may become dull. By forcibly applying a piece of heavy canvas directly to the commutator and collector ring with a stick, a burnishing action is achieved which effectively removes the accumulation.

IM-9

LESSON PLAN

HEATER, LIGHTS, BATTERY, AND TROUBLE SHOOTING REVIEW

OBJECTIVE:

1. To present in general the heater, lights, and battery of the AAFCS M33,

2. To discuss the location of these components, and

3. To review troubles and to develop a trouble shooting technique.

INTRODUCTION:

The material presented in this lesson is not completely necessary for the operation of the AAFCS M33. However, this material is necessary to the comfort of the operators and the proper operation of the set. Heat is an important factor in the efficient performance of the operators in cold climates; lights are necessary for working at night. The operator's comments may be an important aid in the performance of the technician's job. From him, many hints regarding the solution of a trouble may be received. The operators and the technicians should be on the best of terms since high battery efficiency will be obtained only by close harmony among the battery members.

PRESENTATION:

1. Heating and Ventilation (Fig. 19-95).

   a. The components used in providing stand-by battery power and personnel heating and ventilation are contained in the heater cabinet located in the right side of the radar cabinet.

   b. The major components are:

      1) Two 12 volt storage batteries,

2) A selenium rectifier for battery charging,

3) A gasoline heater,

4) An air blower driven by a 1/2 horsepower 3-phase, 208 volt 400-cycle motor, and

5) A thermostat.

c. Battery power is required for stand-by operation of the following:

1) The telephone switchboard,

2) Trailer lights,

3) Gasoline heater, and

4) Aircraft warning siren.

d. As soon as the motor generator set is operating, the battery charger provides a 28 volt DC at a maximum load of 10 amperes to keep the batteries at full charge.

e. The personnel-ventilation blower is controlled by a switch on the control panel.

f. The heater is controlled by a separate switch on the front of the heater cabinet.

g. The heater operation is as follows.

1) The OFF-ON switch supplies 24 volts to the fuel pump, shut-off solenoid, restriction solenoid, FLAME DETECTOR switch, combustion motor, and the ignitor.

2) After approximately 20 seconds, the FLAME DETECTOR switch will activate, removing excitation from the ignitor and applying -24 volts to the ventilation motor and the safety-valve solenoid.

3) When excitation is applied to the ventilation motor, a steady stream of hot air emerges from the heater.

4) The restriction solenoid, controlled by the thermostat, regulates the amount of fuel to the combustion chamber.

5) Should the combustion chamber overheat, the OVERHEAT switch will remove the -24 volts from the shut-off solenoid.

   a) Fuel will no longer flow into the combustion chamber.

   b) The combustion chamber will cool.

   c) The FLAME DETECTOR switch will deactivate, removing -24 volts from the ventilation motor and the safety-valve solenoid.

   d) The safety valve then prevents fuel from entering the storage compartment.

   e) When the combustion chamber cools, the OVERHEAT switch will reapply -24 volts to the shut-off solenoid.

6) The heater may be restarted before the combustion chamber has cooled completely by pressing the safety-valve RESET button.

   a) Pressing this button will allow fuel to flow through the control valve to the combustion chamber.

   b) The fuel will ignite in the combustion chamber, and the normal operating sequence is followed.

7) If the combustion chamber has cooled to a point at which the fuel will not ignite, the complete operating procedure must be followed.

2. The Interior Lighting System.

a. The interior lighting system of the AAFCS M33 is normally supplied with 120 volts, phase A, from the operation of the RADAR switch.

1) The lighting system contains nine ceiling lights.

2) Each is equipped with one white lamp and one blue lamp.

b. These lights are controlled by a single-pole, double-throw, door-operated switch.

1) The change-over from white lamps to blue lamps is done by this switch.

2) This switch is the BLACKOUT-OVERRIDE switch, S2/G5 (Fig. 19-95).

3) When it is in the OVERRIDE position, the white lamps are ON all the time.

4) When it is in the BLACKOUT position, the color of the lamps is controlled by the position of the rear door.

a) Opening the door causes the blue lamps to light.

b) Closing the door causes the white lamps to light.

c) The brightness of the white lamps can be controlled by the CEILING LAMPS switch on the tracking and tactical control panels in conjunction with ON-REMOTE switch S3.

c. There are four white ceiling lights provided for an emergency.

1) These lights are equipped with a -24 volt lamp which is lit by the two 12 volt batteries contained in the heater unit.

2) They are controlled by the same switches that control the regular lighting system.

a) These lights will always operate when the BLACKOUT-OVERRIDE switch is in the OVER-RIDE position.

b) The lights will also operate if the BLACKOUT-OVERRIDE switch is in the BLACKOUT position and the ON-REMOTE switch is in REMOTE.

3. Batteries and Battery Charger.

a. The batteries and battery charger are located in the heater unit.

b. The batteries are two 12 volt storage batteries.

c. These batteries are connected in series to give a 24 volt, DC supply.

d. The battery charger is a selenium rectifier.

e. A 15-amp fuse prevents discharging of the batteries at an excessive rate.

4. Trouble Shooting Review.

a. Use the material from the following lesson plans in volume V:

1) "Trial-Fire Indicator and Time-To-Burst Integrator,"

2) "Plotting Boards Block, and Associated Circuits, "

3) "Pen Interchange, Reference, Mark and Timing Mark Circuits, " and

4) "Fire and Cease-Fire Marks."

b. The troubles given during the classroom period are to be according to the needs for replacement and repair.

SUGGESTED TROUBLES AND ACTIVITIES:

	Symptom	Fig. No.	Trouble
1.	Left pen does not move in an X direction.	22-2	Remove terminal no. 61 of E4 on horizontal board.
2.	Altitude pen oscillates in Y direction.	22-5	Remove terminal no. 64 of E4 behind altitude board.
3.	No reference mark.	22-6	Remove terminal no. 34 in TCC.
4.	No automatic pen interchange.	22-6	Remove terminal no. 38 in TCC.
5.	No interchange in AUTOMATIC or MANUAL.	22-6	Put paper into the contacts of K51 (6T and 7T).
6.	No timing mark.	22-7	Place a bad V81 in the integrator.

	Symptom	Fig. No.	Trouble
7.	No timing mark on altitude board and no Y component of timing mark on horizontal board.	22-2	Place paper between the contacts of K96 (3T and 4T).
8.	No fire or cease-fire marks.	22-7	Place paper between the contacts of relay K92 (4T and 3T).

LESSON PLAN

BRAKES, SWITCHBOARD, AND TROUBLE SHOOTING REVIEW

OBJECTIVE:

To explain the characteristics of the switchboard and the trailer brakes.

INTRODUCTION:

The brake system and the switchboard for the AAFCS M33 will be covered in this lesson. The battery repairman must know how to hook up and check the brake system in the event of a move. The switchboard is used to coordinate battery activities and to provide communication with higher echelons. Trouble shooting procedures will be reviewed.

PRESENTATION:

1. Electric Brakes.

    a. Four electric service brakes, controlled from the prime mover, are provided for the fire-control system trailer.

        1) In addition, the brakes on the wheels of the rear axle may be applied mechanically by a lever under the body on the curb side of the trailer.

        2) Either 6 volts or 24 volts may be used with the brakes in the prime mover.

        3) The electric brakes are connected as a 6 volt or a 24 volt system to agree with the electrical system of the prime mover being used.

    b. The brakes are applied by a controller in the prime mover cab.

1) For a slight application of the brakes, the full resistance of the controller is in series with the prime mover's battery and the four brakes of the fire control trailer.

2) The effective controller resistance is decreased as the brakes are further applied until, in the fully applied position, all the controller resistance is removed and the full voltage is applied to the four brake magnets.

3) When the prime mover being used has a 6 volt system, the four trailer brakes are connected in parallel by means of movable jumpers in the brake terminal box.

4) A series arrangement is made when the prime mover being used has a 24 volt system.

5) A safety switch, attached to the draw bar on the trailer, closes to apply the brakes if the trailer accidentally becomes disengaged from the prime mover.

   a) If the trailer becomes disengaged, the chain attached to the prime mover pulls the switch arm closing the switch.

   b) Power from the storage batteries in the heater cabinet is used to energize the brakes when the safety switch closes.

c. The electric brake consists of a brake drum and armature which revolve with the wheel and a brake band, cams, and a magnet which are secured to a stationary backing plate.

   1) When the magnet is energized, it tends to cling to the revolving armature. The resulting angular displacement of the magnet operates cams to force the end of the brake band against the inside of the brake drum. The brake band then wraps itself onto the drum.

2) As the current through the electromagnet is increased, as increasingly greater force is exerted by the brake band against the drum until the magnet and armature lock together causing the tire to slide.

2. Switchboard and Telephone Connections (Fig. 19-93).

a. The communications system for the AAFCS M33 consists of two switchboards and lines leading to the various battery installations.

1) The administrative switchboard BD-91 is a conventional 24-drop board.

a) Direct lines are wired through this board to the following locations: the tactical control console, the early warning plotting board, and the motor park.

b) There are four spare lines and four trunk lines to this board.

c) Switches S3 through S18 are sliding switches used to set up the two "hot loops": independent, conference circuits.

2) The control switchboard SB-100 is used to control the lines going to the administrative switchboard in accordance with the tactical situation. For example, when the "battery alert" signal is given, the two "hot loops" are activated at the control switchboard.

a) Lines to the following persons and locations pass through the control board, SB-100: the battery commander, the trailer roof, the generator, the acquisition RF coupler, the tracking console, the guns, the executive officer, and four machine guns.

b) There are also two spare lines.

b. Discussion of Loop 1 Connections.

1) When the BATTERY ALERT push button on the monitor control is pressed or when the RELEASE-TEST switch S2A on the SB-100 is pressed, a "hot loop" is activated with the following:

a) The power plant,

b) The acquisition RF coupler,

c) The tracking console,

d) The guns, and

e) The executive officer.

2) There are also four spare lines in the "hot loop": L6, L7, L14, and L15. Any of these ten lines can be removed from the "hot loop" by moving the proper sliding switch (raising the movable arm of one of the switches S3 through S10 or S13 through S16).

3) The three lines going into the SB-100 switchboard, which are numbered L13, L14, and L15, can be connected directly to the administrative switchboard BD-91 or to either "hot loop" 1 or "hot loop" 2 by placing the three-position slide switches S10 through S18 in the proper position.

a) Consider line L13. The three, three-position slide switches S10, S11, and S12 associated with this line and its relay K10 must all be placed in the same position. When these three switches are in the upper position and relay K10 is energized, L13 is connected in "hot loop" 1.

1. The center position connects L13 with the administrative switchboard, and K10 cannot be energized.

2. The lower position connects the line to "hot loop" 2 when relay K10 is energized.

3. In the upper or lower positions of switches S10, S11, and S12 before relay K10 is energized K13 goes directly to the administrative switchboard.

4. When K10 is energized, L13 will either be connected with "hot loop" 1 or with "hot loop" 2 depending upon the setting of the three slide switches.

5. When these three sliding switches are in their center positions, relay K10 cannot be energized; and L13 is connected only to the switchboard BD-91 at all times.

b) In similar manner, L14 and L15 can be set up for operation only to the administrative switchboard or to either "hot loop" 1 or 2 when their respective relays K11 and K12 are energized.

INSTRUCTOR'S NOTE: S10, S13, and S16 should be shown as three-contact switches. The center contact (labeled SWBD on the equipment) is an unconnected contact which prevents the associated relay from becoming energized when the three slide switches are placed in their center positions. S11 and S12, for example, are three position slide switches, each of which control one of the two wires comprising L13. This is not indicated because these two lines have been combined into a single line going into and out of relay K10.

1. Two wires from the data junction box are sent to the switchboard SB-100 and are connected to a pair of relay clappers.

2. When K11 is not energized, the two wires are connected through two contacts directly to switchboard BD-91.

3. K11 can be energized by -24 volts obtained when the BATTERY ALERT push button or RELEASE-TEST switch S2A is pressed. From either source, the voltage is applied through slide switch S13 to the winding of relay K11.

4. When K11 is energized, a holding circuit allows the -24 volts to be applied to the relay windings through RELEASE-TEST switch S2B. When K11 is energized, the two wires of L14 are connected through relay contacts to loop 1 through S14 and S15.

c) It can be seen that if S13, S14, and S15 are placed in the lower position, L14 is connected to "hot loop" 2 when K11 is energized.

d) If S13, S14, and S15 are placed in the center position, S13 prevents K11 from ever becoming energized.

e) Note that when RELEASE-TEST switch S2B is opened, K11 cannot be held energized except during the time the BATTERY ALERT push button or RELEASE-TEST switch S2A is closed. For this reason, a clamp is provided with the SB-100 so that RELEASE-TEST switch S2B can be clamped open when a switchboard operator is not on duty. This protects the relays by preventing their being energized for long periods of time as a result of operation of the BATTERY ALERT push button.

c. Discussion of Loop 2 Connections.

1) As the slide switches are shown on Fig. 19-93, loop 2 consists of the four phones at the four machine gun positions.

2) L13, L14, and L15 can be placed in loop 2 by properly setting their respective slide switches.

3) The battery commander and the tactical control officer can switch their phones to loop 1 or loop 2, or directly to the administrative board by operating their three-position switches.

d. Controls On Administrative Switchboard BD-91.

1) A strip of five turn-button keys is located on the upper right panel. The controls are as follows.

a) NIGHT ALARM OFF-ON. When this key is at the ON position, an incoming call will cause a buzzer to operate when the drop signal falls. To stop the buzzer, the key must be turned to OFF.

b) RINGING HAND-KEY. When the key is turned to HAND, ringing must be done by use of the hand generator. When it is turned to KEY, the switchboard is prepared for the application of power-ringing current.

c) BATTERY 1-2. This key selects either battery 1 or battery 2 to supply energy to the cord circuit and transmitter battery.

d) GROUPING OFF-ON. When two switchboards are used as a single unit, the key of the unattended switchboard is placed ON and its cord circuits are associated with the operator's circuits at the attended switchboard.

e) EXT BAT OFF-ON. If it is desired to use an external battery as the battery source, this key should be turned to ON.

e. Conference Circuit.

Directly below the five turn-button keys are four jacks used to place four of the BD-91 lines in a conference connection.

3. Review.

Review main points of lesson, including functional operation, over-all purpose, and requirements of the electric brakes and the switchboard.

LESSON PLAN

CLUTTER AND COVERAGE DIAGRAMS AND TROUBLE SHOOTING REVIEW

OBJECTIVE:

1. To discuss the clutter and coverage diagrams, and

2. To develop a logical sequence of trouble shooting.

TRAINING AIDS:

1. Film TF-1323.

2. Diagrams for clutter and coverage exercise.

INTRODUCTION:

One of the most important considerations in the selection of a radar position is the radar line-of-sight. The suitability of any location for a radar site can be determined by an analysis of clutter and coverage diagrams. These diagrams are a great aid to higher echelons for planning. They are an aid to maintenance personnel as well. From these diagrams, information concerning the performance of the transmission and receiver system can be determined. This information can be obtained by a quick visual check.

PRESENTATION:

1. A clutter diagram is a pictorial representation of the number, location, and size of fixed echoes obtained at a particular site.

    a. It is a graphical sketch of the clutter presented on a radar PPI.

b. Once a target has been acquired, little, if any, difficulty is experienced in tracking the target through clutter.

c. The clutter diagram is made on polar-coordinate paper.

INSTRUCTOR'S NOTE: Pass out diagrams as needed.

1) Azimuth lines are placed every 200 mils.

2) Concentric range circles can be marked at range intervals desired.

2. A coverage diagram is a pictorial representation of restrictions in coverage occasioned by the shielding effect of nearby terrain features and other objects.

a. A coverage diagram will show, for all directions, the maximum ranges at which the radar set can pick up targets flying at various altitudes.

b. The coverage diagram is made on polar-coordinate paper.

1) Azimuth lines are placed every 200 mils.

2) Contour lines will be drawn to indicate the maximum slant range at which the radar set can pick up a target flying at a certain altitude.

3. The film TF-1323 will show the construction of clutter and coverage diagrams.

a. An alternate method of making a clutter diagram is to trace the clutter on the PPI.

b. An alternate method of making a coverage diagram is with the use of an aiming circle.

INSTRUCTOR'S NOTE: At this point, film TF-1323 should be presented. The film is 25 minutes long. Throughout the running of the film, the main points should be brought to the attention of the student.

c. The site suitability can be determined by these two diagrams.

This analysis is from both the operator's point of view and the tactical point of view.

d. The following diagrams are two completed clutter and coverage diagrams.

INSTRUCTOR'S NOTE: The diagrams should be explained. Answer any questions concerning them. Students should be told that they will complete one in the park. An example of a simple diagram of Fort Bliss and surroundings should be completed in the classroom.

TROUBLE SHOOTING REVIEW:

1. Use the material from volume V on:

   a. Azimuth, elevation, time-of-flight [4/] servos,

   b. Predicted-target coordinates, and

   c. Ballistic synthesis.

2. Troubles in this section should be given in the order of their needs for replacement or repair.

[4/] This may be referred to as the time-to-intercept servo in other publications.

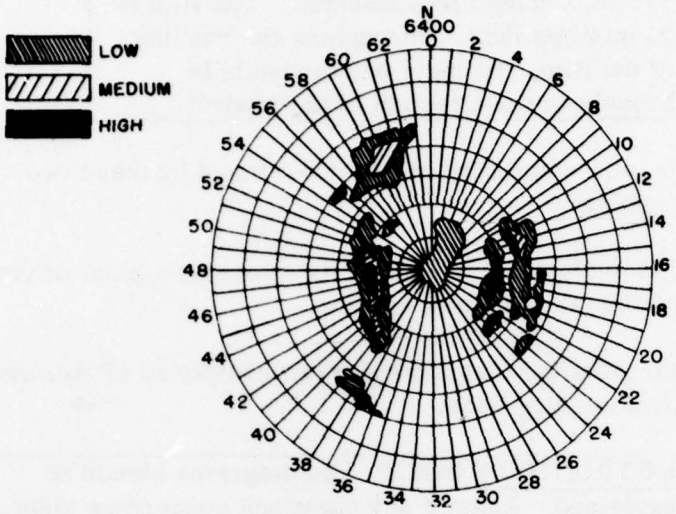

Diagram 5. Clutter

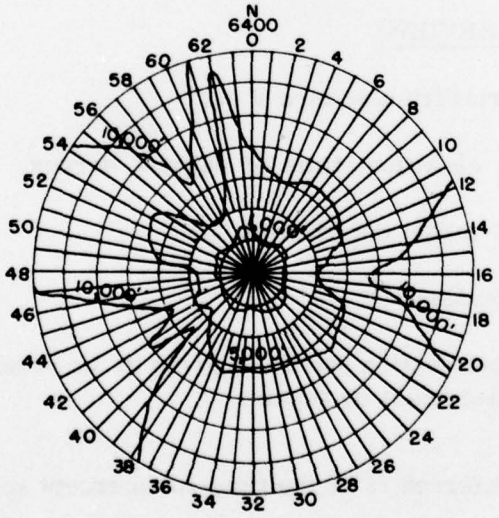

Diagram 6. Coverage.

SUGGESTED TROUBLES:

	Symptom	Fig. No.	Trouble
1.	Pen control is "lost."	22-6	Input and output plugs on prediction control panel removed.
2.	Oscillation in servo.	22-2 to 22-5	Tachometer feedbacks removed from any servo.
3.	No correct reading for static test.	21-20	Static test voltage divider.
4.	Azimuth servo oscillates.	21-7	Remove plug 42 on ballistic resistor panel.
5.	Elevation reads maximum in all tests. Time-of-flight and fuze servos off.	21-9	Open terminal no. 722.
6.	Servo will not move.	20-6	Place a bad tube in LPSA.
7.	Azimuth servo reads off in static test NO. 1 and NO. 4.	21-7	Open terminal NO. 707.
8.	Azimuth servo reads off in test NO. 5 and slightly off in test NO. 6.	21-4	Open terminal NO. 784.
9.	All servos off in test NO. 6.	21-13	Open terminal NO. 800.

	Symptom	Fig. No.	Trouble
10.	Time of flight oscillates in all tests.	21-11	Open terminal no. 896.
11	Time of flight is off in all tests.	21-16	Open terminal no. 734.
12	Elevation is in error in all tests.	21-17	Open terminal no. 873

LESSON PLAN

PREVENTIVE MAINTENANCE

OBJECTIVE:

To explain preventive maintenance and the reasons for its periodic performance.

INTRODUCTION:

A thorough preventive maintenance program will save the repairman many hours of unnecessary work and trouble shooting. It will also save the government a lot of money. The purpose of this lesson is to explain and show the student the proper methods used in a well-rounded perventive maintenance program.

PRESENTATION:

1. Barbette.

   a. Acquisition Magnetron.

      One of the most important items in the preventive maintenance procedures is the periodic check of the acquisition magnetron and "hot box."

      1) Inspect the rubber air hose going to the magnetron. Make sure it is free of leaks and tight bends which may collapse the walls.

Caution: Do not replace air hose with black, thin-walled hose. Use no. 250 thick-walled, surgical rubber hose.

      2) Inspect "hot box" to see that it is free of sand, grit, oil, and metal filings.

3) See that filament connections to magnetron are clean and free of corrosion. Use sandpaper or fine crocus cloth to clean the connections.

b. Filters.

These filters must be removed and shaken until free of dust.

c. Preventive Maintenance Checks.

1) Check that all cables, including HV pulse cables, are connected securely.

2) Check that the dust seal is filled with grease.

3) Check that tripod legs are securely anchored.

4) Check that all compartment gaskets are in good condition.

5) Check that blower motor runs free of vibration.

6) Check that interior of the barbette is free of dirt and sand.

7) Check that all meters read correctly.

8) Check that hydraulic system is full and is free of leaks.

9) Check that wires do not show signs of wear or burning.

10) Check that all units are securely mounted.

11) Look for bulging transformers and oil or tar leakage.

12) Check that all interlocks operate.

2. Track Antenna.

a. Track Magnetron.

The care of the track magnetron and "hot box" is almost identical to the care of the acquisition magnetron and "hot box."

Caution: When replacing the track blower motor housing, make certain the ventilation tube is fitted correctly to the slot in the housing.

b. Preventive Maintenance Checks.

1) Check that all hardware such as screws, covers, clamps, brackets, and chains is in place.

2) Check that upper optics desiccant is dark blue.

3) Check that all cables are secure.

4) Check that V-blocks are clean and free of paint.

5) Check that all paint is in good condition.

6) Check that all gaskets are in good condition.

7) Check that all units are securely mounted.

8) Check that RF coupler is clean and free of dirt and sand.

9) Look for leaking oil, tar, or bulging transformers.

10) Check that all interlocks operate.

11) Lower the azimuth drive cover and check the following.

a) The drive ring is clean and free of dust.

b) Feel the drive motors to see if one is heating up more than the rest.

1. If one of the drive motors is heating excessively, check the BALANCE ADJUST on the corresponding HPSA, and make sure that the drive roller is not slipping on the drive ring. Tighten adjustment if necessary.

2. A paste composed of powdered carborundum and water applied to the inside of the drive ring will often eliminate roller slippage, especially in windy weather.

c) Plastic lenses are on the three periscope eyepieces.

d) If the inspection plate on the top part of the pedestal is removed, make sure the gasket is not crimped while being replaced. Be especially carefull of this in wet weather.

3. Radar Cabinet.

a. HV Compartment and Track Modulator.

1) Check for oil leaks and frayed or burnt insulation.

2) Make sure all connections are secure.

3) Look for bulging transformers.

4) Make sure all interlocks and shorting bars operate properly.

5) Make sure all three compartments are clean and free of dust and dirt.

b. Preventive Maintenance Checks.

1) Check that batteries are free of corrosion and filled to the proper level.

2) Check that HV stops are set correctly on HV pots.

3) Check that battle-short seals are intact.

4) Check that all switches and lights operate properly.

5) Check that all DC voltages are within tolerance.

6) Check the blower motors for dust by listening or feeling for excess vibration. A collection of dust will unbalance the armature, and the resulting vibration will damage the bearings.

7) Check that interlocks are operating properly.

8) Check that all fuses are of the correct value.

9) Check that all door gaskets are good. The radar cabinet was designed for maximum ventilation with all the doors closed. If the air is allowed to leak out through incorrectly fitted doors and broken gaskets, the ventilation will be decreased.

10) Check that all cables and coaxial connectors are on tight.

11) Check the chassis slides for smooth operation.

12) Make sure all stops on chassis slides are functioning properly.

13) Check for missing tube shields.

14) Check all cables that may become frayed because of constant sliding of chassis.

4. Track Console.

   a. Check that all switches and controls operate properly.

   b. Check that all indicators are adjusted properly.

   c. Check that creep has been eliminated from all servo positions.

   d. Check that all cables and connectors are secure.

   e. Check that all hardware is in place.

   f. Check that the main blower is operating properly.

   g. Check that all interlocks are operating properly.

   h. Check that the console is free of dirt.

   i. Check all the wiring that may become frayed because of chassis movement.

   j. Check for evidence of components which may be overheating.

   k. Check that the indicator HV supply is free of oil and dirt.

   l. Check that all gaskets are in good condition.

5. Periscope.

   a. Check that lower desiccant is dark blue.

   b. Check that all lenses are clear.

   c. Check that rubber eyepieces and plastic lenses are clean and in place.

   d. Check that all plate gaskets are good.

e. Check that the filter selector and the eyepiece selector work properly.

6. Tactical Control Console.

a. Check that all switches are operating properly.

b. Check that monitor control functions properly.

c. Check that all compartment interlocks function properly.

d. Check that all doors and gaskets are in good condition.

e. Check for frayed wiring. (Check especially under the tactical control PPI where the cables can become caught between the sliding chassis and the frame.)

f. Check that the plastic meter cover is in place and taped.

7. Switchboard.

a. Check that all brass phone-plugs are clean.

b. Check that all the drops will stay up.

c. Check that the RELEASE-TEST switch works.

d. Check that the hand generator operates freely.

8. Van Interior.

a. Check that the escape hatches close and lock properly.

b. Check that the entire van is clean.

c. Check that the ceiling lights work properly.

9. Van Exterior.

a. Check that all cables are in place and secure.

b. Check that clamshell is latched.

c. Check that the air filters are clean.

PRACTICAL EXERCISE

TROUBLE SHOOTING REVIEW

INSTRUCTOR'S NOTE: This exercise will cover the last seven days of the field-procedure portion of the M33 phase of the AAFCS M33 Fire Control Technician Course.

PRELIMINARY TROUBLE:

Each day, troubles will be selected from previous exercises.

INSTRUCTOR'S NOTE: Have the students completely energize and check out the system. Place preliminary troubles in the acquisition and tracking radars and in the computer. Several troubles should be placed in each. Be careful that the troubles placed in the equipment do not interact.

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY:

1. Two multimeters,
2. Synchroscope,
3. Test amplifier, and
4. Null voltage test set.

PROCEDURE:

Note: This exercise covers Lesson Plans IM-7 through IM-12.

1. Troubles will be placed throughout the equipment indiscriminately.

2. Critique each trouble to insure proper trouble shooting methods.

> INSTRUCTOR'S NOTE: The entire time allotted for the seven days will be utilized for trouble shooting. Troubles taken from previous exercises will be placed throughout the equipment at random. Intermix the troubles so the students will not get into the habit of looking along only one or two channels.